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POISONOUS PLANTS OF INDIA

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PREFACE

The knowledge of poisonous plants is perhaps as old as the human race itself, and yet it is surprising that no attempt has hitherto been made in India to consolidate the information which has accumulated through ages by accident, trial, experience, and research. In various books on medicine or on economic plants, occasional references are undoubtedly made with regard to the poisonous properties of a number of plants growing in the country, but the fact remains that there is, so far, no exclusive and comprehensive treatise on the subject. No apology is, therefore, needed for presenting this monograph to the reader.

The importance of the study of poisonous plants to an over-populated and a predominantly agricultural country like India cannot be overrated. On the one hand they are a serious menace to life and bodily functions of man and animals, yet, on the other, many of them in regulated doses constitute potent and effective remedies for amelioration of disease. Some of them, while poisonous to insects and other cold-blooded animals, are comparatively harmless to man and warm-blooded animals, and are being increasingly utilized for the fight against insect pests. In other words, poisonous plants are at once great destructive and constructive agents in the economy of a nation. It is, therefore, of fundamental importance to any country to gain a complete knowledge of their distribution, chemical constituents, and physiological action. This is true with much greater force in the case of India, with recurring famines, inadequate medical facilities, poverty, and a host of insect-borne diseases. It is only after such investigations that suitable measures can be adopted to prevent or mitigate their destructive effects, and to harness them for the benefit of the nation.

The importance and potentialities of the subject led the Imperial (now Indian) Council of Agricultural Research to sanction in 1935 a scheme for the study of medicinal and poisonous plants of the country. As a result of this over 3,000 circulars with suitable questionnaire on poisonous plants were issued to various Government departments, universities, and private individuals, and extensive tours all over India were undertaken. In this way not only a good deal of information was collected but also a large collection of actual specimens was made. This collection, known as CHOPRA BADHWAR HERBARIUM, up to date comprises about 6,000 specimens representing about 1,700 species of medicinal and poisonous plants out of a total of a little over 2,000 found in the whole of India. Most of the poisonous plants dealt with in this monograph are represented in this herbarium, which has been split up into 3 parts ; one set has been presented to the School of Tropical Medicine, Calcutta, the second to the Forest Research Institute, Dehra Dun, and the third is being temporarily housed at the Drug Research Laboratory, Jammu Tawi. During these tours samples of a number of supposed poisonous plants were also collected and investigated by the authors. The results of these researches are incorporated in the body of the monograph. As a result of the extensive tours throughout the country and replies to the above-mentioned circulars, a good deal of information was collected and sifted. The monograph thus written was sent to the press in 1940, but, owing to war and scarcity of paper in the country, its printing was suspended. It was only late in 1944 that printing could be resumed by a special priority permission of the Government of India, who at first allowed only one volume comprising not more than 800 pages. Recently, however, they have allowed the publication of the second volume also, and attempts are being made to bring out this as soon as possible. Being one of the " casualties " of the war, some of the blocks, in spite

of every precaution, have been slightly damaged owing to long storage in a humid climate, but on the whole they have come out well.

It has been the dominant object of the authors to furnish the readers with a complete outline of the botanical, chemical, pharmacological, and economic aspects of poisonous plants dealt with in this work, especially from the point of view of their practical importance. The monograph has been profusely illustrated and deals with about 700 plants poisonous to man, livestock, insects and fishes, their vernacular names, botanical descriptions, distribution and economic aspects, and, where known, important chemical constituents and physiological action, the symptoms produced by them and the lines of treatment and prevention of poisoning.

The poisonous plants have been arranged in families according to Bentham and Hooker's system of classification, which has been followed in the "Flora of British India" by Hooker. Most of the provincial and local floras and the herbaria in India are also arranged according to this system. The arrangement and limitations of families as adopted in the "Flora of British India" are so widely understood and followed in India that it has not been considered desirable to make departures from this, at least under the present conditions. Any other arrangement or limitation of the families would be confusing to many, especially to the nonbotanists, who will form a considerable proportion of our readers. The arrangement followed in this work is, therefore, of practical convenience to a large number of our readers. Under each family are described genera and species, which are arranged alphabetically; this arrangement again is adopted for practical convenience.

In the accounts of the families a general survey has been attempted of the poisonous plants of the whole world, their salient properties and chemical constituents. Despite the

gaps that may have been left, it is hoped that these surveys will be helpful in assessing to a degree the properties and chemical constituents of a large number of the related Indian plants about which very little is known at present, since it is a common knowledge that allied plants often have similar chemical components and properties. These surveys also include a large number of plants of commercial importance and also those with which the reader is familiar, such as garden plants. The object is to enable the reader to appreciate the relationship of poisonous plants to other plants of economic interest of a particular family. This will also enable a nonbotanist to understand and appreciate something about the family in order to take an intelligent interest in the accounts. Wherever desirable on merits and to avoid repetition of the same information under different species, generic accounts have been elaborated under the genera with a view to indicating their salient features. Readers, who desire to have a complete knowledge of the known or probable properties of species which have hitherto been little or not investigated, are, therefore, advised not only to read what has been written under each species, but also to refer to what has been stated in the accounts of the genera and the families to which they belong.

All poisonous plants found in India, whether cultivated in gardens or fields or growing wild, have been dealt with in detail. All others which are not grown even in gardens have been treated as foreign. Only passing references have been made with regard to the properties and chemical constituents of foreign plants, but, wherever greater details were indicated with a view to throwing light on hitherto lesser known Indian species, these have been given in appropriate places.

Special attention has been paid to the nomenclature of Indian plants, and adherence to International Rules of Botanical Nomenclature has caused many departures from the names

used in the "Flora of British India". A large number of genera and species, as described in that monumental work, are differently understood or are differently named or spelt by modern botanists. In some cases the validity of new names and spellings has been checked by the present authors; in others, these changes have been verified from the works of well-known botanists. Wherever the name adopted in this work differs from that of the "Flora of British India", the latter name is given as a synonym for the benefit of those who have become accustomed to the "old" names. In addition, a few other synonyms have been cited and these pertain to those plants where the publications consulted happen to adopt names other than those followed in this work. It is considered unnecessary to deal with complete synonymy, and readers interested in this line are referred to botanical works.

A list of the Latin names adopted in this work was sent to Kew for verification. A few mistakes that were noticed were corrected, and the list was returned with the remarks that the synonymy was done "so carefully that a complete check appears to be unnecessary". We are most grateful to the experts at Kew for their suggestions, and greatly appreciate and value the help given by them. Since then, however, we have made a number of additions and changes and take the entire responsibility for the final synonymy adopted.

An attempt has been made to give an exhaustive list of vernacular names of plants which have been dealt with in detail. A number of them, as recorded in various publications, are superfluous. Very many of them will be found with slightly varying spellings. Much as we desired and attempted, we must admit that it has not been possible to standardize their spellings or forms or to eliminate the whole mass of superfluous names, owing to the limited time at our disposal and to the diversity of languages and dialects with all of which we ourselves are not familiar. All that we have done is to

collect most of the recorded vernacular names and try here and there to sort out those which we could handle ourselves or with the help of a few friends. Nevertheless, we are conscious of the perpetuation of many erroneous or useless names which we ourselves dislike, but we hope that a stage has been set for further improvement. We earnestly desire that sooner or later the matter of standardization of these names will receive better attention than has hitherto been paid to it. When this is done it will be found that many a name which is being perpetuated in books will have to be omitted. Despite all the shortcomings, however, vernacular names have a certain value in the identification of plants, and this consideration alone prompted us to include them in such a detail. We, however, warn our readers not to rely on them as a short cut to identification, since serious risks of errors are involved in this method. If the reader must persist in this, he is strongly advised to confirm his conclusions by reference to botanical descriptions and illustrations.

A good deal of care has been taken in drawing up the botanical descriptions. A comparatively small number of plants described in the monograph are spread over the whole of this vast country and are intermixed with a much larger number of other plants. Even the experts in such cases often require, for correct identification, not only the descriptions of plants but also the characters in which they differ from closely allied species growing in the same area. In order that these botanical descriptions may be of practical use in the identification of plants, they should contain information for distinguishing them from other allied plants. Without attempting detailed and complete botanical descriptions, which would have made the monograph bulky, we have tried to make them useful for distinguishing the poisonous plants not only from one other, but also from many nonpoisonous ones which may be found in the same area. Wherever possible and desirable

the generic and specific keys have also been supplemented with special characters likely to be useful for this object. It is hoped that these descriptions and keys, supplemented in many cases by illustrations, will prove helpful in the identification of plants described herein.

Within the short time available at our disposal, and the fact that plants described in this work are dispersed all over India, it has not been possible to give original figures in most cases. A large number of the illustrations have, therefore, been taken or adapted from the works of well-known authors. Wherever this has been done, the fact is acknowledged under the "List of Illustrations" on pages xxix to xxxvii.

No attempt has been made to give a detailed chemistry of poisonous plants, but stress has been laid only on such constituents as are likely to be responsible for their poisonous nature. In many cases investigations have been made on Indian materials, but in a number of others work done elsewhere on the same species has been quoted, since it is well known that identical plants, generally, have the same chemical constituents.

Whenever a plant has been investigated pharmacologically, detailed information has been given with regard to its toxicological aspects, the action of active principles, the symptoms produced in man and animals, post-mortem appearance, the lines of treatment and prevention of poisoning. Considerable gaps, however, still exist in the toxicology of a number of Indian plants and, therefore, it has not been possible to give a full picture in all cases.

Although the manuscript was completed in 1940, the publication of the monograph has been considerably delayed. In order to bring the information up to date, the authors have, consequently, decided to add an appendix in the second volume, incorporating researches that have since been carried out.

An index has been given of the Latin names of plants dealt with in this volume. A complete index of the Latin, English and vernacular names, plant constituents, etc., will be given at the end of the second volume.

The monograph has been prepared primarily to serve the botanists, chemists, medical practitioners, veterinarians, agriculturists, and foresters. The research worker will find copious references to the work already done on each plant, and will also get an indication on further lines of investigation. To those in India who are engaged in the investigation of drugs, this work will be useful in so far as it offers a wide choice to select potent materials for their research. The general public will also find the information of direct value to them. Not only will the reader find accounts of such potent plants as aconites (*Aconitum* sp.), belladonna (*Atropa belladonna* Linn.), etc., but he may at first be surprised to find in the text labelled as food poisons such plants as potato (*Solanum tuberosum* Linn.), coffee (*Coffea arabica* Linn.), tea [*Camellia sinensis* (Linn.) Kuntze], buckwheat (*Fagopyrum esculentum* Moench), 'khesari dal' (*Lathyrus sativus* Linn.), etc. These are normally valuable articles of food or beverages; nevertheless they produce harmful effects under certain conditions and must, therefore, be treated as poisons.

Of the shortcomings of the work nobody is more conscious than the authors themselves, but this is the first time that an attempt has been made to narrate a story of the Indian poisonous plants. As such, it is a pioneer work setting forth what is known about the subject at the present day and pointing out where the gaps exist and need further investigation. There is yet much to be done to improve our knowledge of the chemical constituents and effects of many of the plants so that cases of poisoning in man and animals may be diagnosed and treated intelligently and effectively. A detailed knowledge with regard to their distribution in various provinces is neces-

sary in adopting preventive measures. Similarly, a good deal of research is necessary to find effective medicines and insecticidal plants from among indigenous resources. The authors will feel amply rewarded if they have succeeded in drawing attention to this hitherto comparatively neglected subject and in stimulating interest in the research worker in further pursuits of knowledge which is bound to play an increasingly important role in the postwar economy of India.

We take here the opportunity of expressing our gratitude to the Indian Council of Agricultural Research for the generous grant they placed at our disposal for carrying out this work. We also sincerely appreciate the help given us by the forest, agricultural, veterinary, and medical departments, chemical examiners, universities, and other individuals, both in the field and in the laboratories and herbaria. Numerous, indeed, have been the persons who rendered some help or the other. Since the monograph was first contemplated even the authors have been separated, and, wherever they have been, an ungrudging incidental help from their colleagues has always been forthcoming. We are, however, specially indebted to Mr. S. L. Nayar and late Mr. N. C. Goswami of the Medicinal Plants and Food Poisons Inquiry for the invaluable and abundant help they have rendered, particularly in collecting the vernacular names, in selecting and supervising the execution of illustrations, and in the correction of the proofs. We are obliged to Dr. B. Prashad, O.B.E., lately Director of the Zoological Survey of India, now Fisheries Development Advisor to the Government of India, for making a number of useful suggestions for the get-up of the monograph and for going through the galley proofs. To Dr. K. P. Biswas, Superintendent, Royal Botanic Garden, Sibpur, we offer our grateful thanks for allowing us the use of his excellent herbarium and library and helping us in many other ways. Our sincerest thanks are also due to Mr. V. Narayanaswami, of the Botanical

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GLOSSARY OF BOTANICAL TERMS

A

Abortive : imperfectly developed.

Abruptly acuminate : passing suddenly into a tapering point at the apex.

Acaulis : without a stem.

Accrescent : enlarging in size with age.

Accumbent : lying against.

Achene : a small, hard, dry, indehiscent, 1-seeded fruit ; strictly of a single free carpell as in buttercup, but also used when more than one carpel as in Compositae, in latter case with adnate calyx.

Achlamydeous : applied to flowers devoid of perianth.

Acicular : needle-like, long, slender, and rigid, like the leaves of many conifers.

Acropetal : with the youngest organs nearest to the apex.

Actinomorphic : having flowers of a regular shape, capable of bisection in two or more planes into similar halves.

Aculeate : armed with prickles like the stem of a rose.

Acuminate : tapering to an acute end.

Acute : with a sharp pointed apex.

-Adelphous : a term used in compounds with a numeral, *e.g.*, stamens monadelphous, meaning that the stamens are united into one bundle or tube.

Adherent : when the members of a flower become united in the course of growth to the members in a different whorl and of a different character, *e.g.*, when the stamens become united to the corolla.

Adnate : attached by the whole length, as anther lobes to the filament.

Adpressed : lying close against throughout the whole length, as hairs lying along a stem or against the surface of a leaf.

Adventitious : applied to roots which are not formed from the radicle of the embryo ; or to abnormal buds such as are not produced in the axils of the leaves.

Aestivation : the manner in which the parts of a flower are arranged and folded before expansion.

Albumen : the nutritive material stored within the seed outside the embryo.

Albuminous : containing albumen.

Alternate : applied to leaves which are placed one above the other in different vertical lines, also to parts of a flower, as when stamens are placed between the petals and the petals are between the sepals.

Amphitropous : said of an ovule curved to bring its two ends near together.

Amplexicaul : stem-clasping, as the bases of some leaves or petioles.

Anastomosing : when veins meet and join to form a net.

Anatropous : said of an ovule inverted on its funicle so that the opening is close to the hilum and the chalaza at the other end.

Androecium : the entire male parts of a flower, the stamens collectively.

Androgynophore : a stalk or stipe elevating both the stamens and the pistil of a flower.

Androgynous : male and female flowers in the same inflorescence.

Angiosperms : plants having their seeds enclosed in an ovary.

Annual : applied to plants which germinate and produce flowers and seeds and then die within a single season or year.

Annular : in the form of a ring.

Anterior : the side remote from the parent axis. The antithesis to posterior. Unless twisting of the pedicel has taken place the anterior sepal or sepals of a flower in an inflorescence will be the lower sepal or sepals, the upper one or ones will be called posterior and the side ones lateral.

Anther : that part of the stamen which contains the pollen.

Apetalous : without petals or corolla.

Aphyllous : without leaves.

Apicula : a short, sharp, but not rigid point.

Apocarpous : when the carpels are free and separate.

Appressed : when an organ, as a leaf or a hair, lies flat for its whole length against another organ; same as adpressed.

Arborescent : attaining the size of a tree or resembling one.

Areole : a space marked out in any way; a small cell or cavity.

Aril or arillus : an appendage arising from the hilum and more or less enveloping the seed, as the mace of the nutmeg.

Arista : a bristle-like appendage, common in grasses.

Aristate : bearing an awn or bristle.

Armed : provided with spines, thorns or prickles.

Ascending : directed obliquely upwards.

Asexual : having neither male nor female organs.

Attenuate : narrowed, tapered.

Auricle : a small lobe; an ear-shaped appendage.

Awn : a bristle-like appendage, longer than an arista, frequently occurring on the glumes of grasses.

Axil : the upper angle formed between the axis and any organ arising from it, as that between a stem and a leaf on it.

Axile : said of placentas attached to the inner angles of the cells of a compound ovary.

Axillary : situated in an axil.

Axis : any member which bears lateral subsidiary members may be called the axis of such subsidiary members.

B

Baccate : berry-like; pulpy throughout.

Bark : all the tissues alive or dead situated outside the cambium ring.

Basal : attached to or arising from the base.

Basifixed : fixed to the stalk at the base.

Beak : a narrowed, usually solid prolonged tip; not used for leaves.

Berry : a pulpy fruit with immersed seeds.

Biennial : applied to a plant which requires two years to complete its life cycle, usually flowering and fruiting during the second year.

Bifid : divided into 2 parts halfway down.

Bilabiate : two-lipped.

Binate : 2 arising together from the same point.

Bipartite : divided almost to the base into two parts.

Bipinnate : when the secondary as well as the primary divisions of a leaf are pinnate.

Bipinnatifid : when the lobes of a pinnatifid leaf are also pinnatifid.

Bisexual : when both stamens and pistil are present in the same flower.

Blade : the flat or expanded part of a leaf.

Bract : a modified, reduced leaf from the axil of which a flower or floral axis arises.

Bracteate : possessing bracts.

Bracteole : a bract sitting on the floral axis and usually smaller than the main bract from which the latter springs.

Bulb : a modified bud, usually underground and with fleshy scales or coats.

Bulbil : a small, usually axillary bulb.

C

Caducous : falling off early.

Caespitose : tufted, as many grasses.

Calycine : herbaceous; resembling a calyx in texture.

Calyptra : a cap-like covering of a flower.

Calyx : the outermost series of the parts of a flower; also the enveloping parts of a flower with only one perianth-series.

Cambium : the soft formative tissue from which new wood and bark originate in the stems and roots of dicotyledonous and gymnospermous shrubs and trees.

Campanulate : bell-shaped.

Campylotropous : said of an ovule curved by unilateral growth so that the true apex is brought near the hilum.

Capitate : (*i*) clustered together into a head or ball, as the flowers of Compositae, (*ii*) pin-headed, as the stigma of primrose.

Capitellate : diminutive of capitate.

Capitulum : a close head of sessile flowers, as in Compositae.

Capsule : a dry dehiscent fruit, opening by two or more valves.

Carinate : keeled.

Carpel : a single modified leaf forming an ovary or part of it and bearing the ovules.

Carpophore : the axis of an ovary from which the ripe carpels eventually separate or are sometimes pendent.

Cartilaginous : hard and tough, like the rind of an apple-pip.

Caruncle : protuberance or peculiar growth near the attachment of a seed.

Catkin : a peculiar form of inflorescence consisting of an elongated axis clothed with bracts in the axils of which are usually 1-sexual flowers, usually without, rarely with very inconspicuous, perianth. The whole inflorescence is deciduous together.

Caudate : with a tail-like tip.

Cauline : belonging to or arising from the stem.

Centrifugal : developing from the centre outwards.

Centripetal : developing from the outside towards the centre.

Chalaza : that part of the ovule or seed where the nucellus joins the integuments.

Chartaceous : paper-like in texture.

Chlorophyll : the green colouring matter of plants.

-Chotomous : divided several times into 2 (2-chotomous) or 3 (3-chotomous) forks.

-Cidal: a suffix denoting dehiscence, *e.g.*, loculicidal, splitting down the middle of the carpel, and septicidal, splitting along the septum.

Cilia : marginal hairs.

Circinnate or Circinate : (*i*) rolled up longitudinally with a growing tip inside, (*ii*) coiled like the tail of a dog.

Circumscissile : splitting as if cut around transversely.

Cladode : a branch or single internode simulating a leaf.

Clavate : club-shaped.

Claw : the narrow or stalk-like base found in some petals.

Cleistogamous : flowers that are fertilized within the unopened perianth.

Coccus : one part of a lobed fruit becoming more or less detached from the rest and usually derived from a single carpel.

Coherent : said of similar parts when united.

Collateral : placed side by side at the same level.

Columella : the persistent axis of a fruit from which the rest of the fruit falls away in some cases when ripe.

Column : the stalk of the combined filaments or of styles and stamens.

Coma : the tuft of soft hairs especially at the end of some seeds.

Commissure : the face of adherence of 2 carpels.

Comose : furnished with a tuft of long soft hairs.

Compound : formed of similar parts grouped in a whole; of leaves when composed of more than one separate leaflet.

Conduplicate : folded together lengthwise.

Cone : the fruit of the pine and other gymnosperms.

Confluent: blended or merged into one.

Connate : applied to members of the same whorl when united.

Connective : the portion of a stamen distinct from the filament which connects the lobes or cells of an anther.

Connivent : in contact or weakly cohering.

Contorted : a form of aestivation in which each member in a whorl has one margin overlapped by the preceding member, while the other margin overlaps the succeeding member.

Convolute : rolled up from one or both margins.

Cordate : heart-shaped, *i.e.*, more or less deeply notched at the base and in form like a conventional heart.

Coriaceous : leathery, thick and tough.

Corm : a bulb-like fleshy stem or base of a stem.

Corolla : the interior series of the perianth, a collective name for the petals.

Corona : an inner appendage to the corolla shaped like a coronet, or a more or less interrupted outer appendage to the stamens.

Corrugate : wrinkled.

Corymb : a racemose inflorescence which has the lower flower stalks longer than the upper, so as to bring all the flowers to about the same level.

Costate : ribbed.

Cotyledon : the leaf or pair of leaves present on the embryonic plant while still in the seed.

Crenate : scalloped or toothed with rounded teeth.

Crenulate : crenate but the toothings themselves small.

Crustaceous : of brittle texture.

Cryptogam : a plant which does not produce flowers and seeds in the ordinary sense of these words.

Cucullate : hood-shaped.

Culm : the stem, usually hollow, of grasses and bamboos.

Cuneate : wedge-shaped.

Cusp : a sharp, usually rigid terminal point or beak.

Cuspidate : tipped with a cusp.

Cyathiform : wine-cup-shaped.

Cymbiform : boat-shaped.

Cyme : an inflorescence in which the main axis and all the lateral axes are each terminated by a flower and the flowering proceeds outwards and downwards.

D

Deciduous : falling off, not persistent.

Declinate : bent or curved to one side or downward.

Decompound : repeatedly divided or branched or compound.

Decumbent : having the lower parts prostrate.

Decurrent : prolonged downward from the base.

Decussate : in pairs alternately at right angles.

Definite : limited as to number, not numerous; applied to stamens when not exceeding 20.

Dehisce : to open at maturity by the separation of the walls or valves so as to discharge the contents.

Dehiscence : the mode of opening of a capsule or an anther.

Dehiscent : dehiscing when ripe.

Deltoid : shaped like an equilateral triangle.

Dentate : sharply toothed, especially with teeth not pointing forward or backward.

Denticulate : with little teeth or points along the margin.

Diadelphous : having stamens in two bundles.

Dichasium : a centrifugal inflorescence in which all the axes end in flowers from below which lateral opposite branchlets arise.

Dichlamydeous : having both calyx and corolla.

Dichotomous : forked in pairs.

Diclinous : unisexual, having the stamens and pistil in separate flowers.

Didymous : in equal pairs or connected halves.

Didynamous : in two unequal pairs.

Diffuse : widely or loosely spreading.

Digitate : spreading like the fingers of a hand; in a compound leaf, when the leaflets are all borne at the apex of the petiole.

Dimerous : applied to cycles or whorls consisting of two parts.

Dimorphous : occurring in two different forms.

Dioecious : where the sexes occur on different individuals, the male flower on distinct plant from the female, *e.g.*, in papaya.

Discoid : disc-like, flat and circular.

Disc : a development of the receptacle of a flower as a cushion, ring or glands, within the calyx and under and outside the pistil.

Dissepiment : a partition in an ovary or pericarp caused by the cohesion of the sides of the carpels, sometimes spurious as in Cruciferae.

Distichous : arranged in two vertical rows.

Divaricate : spreading widely apart.

Dorsal : relating to or attached to the back; the surface turned away from the axis

Dorsifixed : fixed by the back.

Drupaceous : more or less resembling a drupe.

Drupe : a fruit with a more or less succulent flesh enclosing a single, 1–many-celled stone, such as a plum.

E

Ebracteate : without bracts.

Echinate : beset with prickles or spines, like a hedgehog.

Ellipsoid : an elliptical solid body.

Emarginate : having a deep dent at the apex.

Embryo : the incipient new plant within the seed.

Endocarp : the inner layer of the wall of a fertilized ovary or a fruit.

Endosperm : the albuminous part of a seed (in angiosperms), often limited to what has been formed within the embryo-sac.

Ensiform : sword-shaped.

Entire : with an even untoothed margin.

Epicalyx : a whorl of bracts on or just below the calyx and more or less resembling it.

Epicarp : the external layer of the wall of a fertilized ovary or a fruit.

Epigynous : borne on the ovary or apparently so.

Epiphyte : a plant growing upon, but not nourished by, another plant.

Epipetalous : on the petals or corolla.

Equitant : folded over as if astride ; said of leaves when in vertical rows with the bases of the outer sheathing those of the inner, *e.g.*, in many of the iris family.

Erecto-patent : between erect and spreading.

Erose : eroded, appearing torn or frayed at the edge.

Exalbuminous : without albumen.

Excurrent : running out beyond the tip or margin.

Exocarp : the outer layer of a pericarp.

Extra-axillary : situated away from the axil of the leaf to which it is nearest.

Extrorse : applied to anthers which open towards the circumference of the flower and not towards the pistil.

F

Falcate : sickle-shaped.

False septum or dissepiment : an inner wall of an ovary which is not formed from the incurved edges of the carpels but is usually of late development.

-Farious : a suffix indicating parts, *e.g.*, bifarious, in 2 parts ; quadrifarious, in 4 parts.

Fascicle : a close cluster or bundle.

Fastigiate : with branches all clustered and erect.

Female : a female flower is one which bears an ovary containing ovules capable of fertilization and becoming seed, and does not bear stamens. A flower which only bears an imperfect or functionless ovary is not considered a female flower. A female plant is one which only bears female flowers.

Fertile : capable of producing fruit ; also used of stamens provided with pollen.

-Fid : cleft, *e.g.*, bifid, 2-cleft.

Filament : the stalk of an anther ; any thread-like body.

Filiform : thread-shaped.

Fimbriate : fringed.

Fistular : hollow throughout the length.

Flaccid : limp, flabby.

Flexuous : wavy, zigzag.

Foliaceous : of the texture and shape of a leaf ; also leafy.

-Foliolate : in composition refers to the leaflets in a compound leaf, *e.g.*, 5-foliolate means with 5 leaflets.

Follicle : a fruit of one carpel opening by one suture only, usually the ventral, to which the seeds are attached.

Free : not united with other members.

Free central placentation : where the ovules are situated on the axis of a unilocular ovary, which may be produced above the base of the ovary or not.

Fugacious : soon perishing ; rapidly falling off.

Funicle : the stalk present in many ovules or seeds.

Furcate : forked.

Furrowed : grooved.

Fusiform : spindle-shaped.

G

Gamo- : a prefix indicating union, *e.g.*, gamopetalous meaning petals united by their edges into one piece, *i.e.*, not divided to the base into separate members.

Geminate : in pairs.

Genus : a natural group consisting of one or more species and which with the species gives the name to a plant.

Gibbous : swollen on one side ; humped.
Glabrate : nearly glabrous.
Glabrous : smooth, without any kind of hairs.
Glabrescent : with deciduous hairs and becoming glabrous.
Gland : a swelling or excrescence of the surface, dry or secreting oil or resin ; an oil vesicle in the epidermis or in the leaves, flowers or fruits ; a lobe of the flower disc.
Glandular : furnished with glands.
Glaucous : bluish-grey or bluish-green.
Globose : somewhat spherical.
Glochidia : barbed bristles.
Glochidiate : bearing barbed bristles.
Glumaceous : resembling the outer empty floral bracts of grasses.
Glume : the bracts and bracteoles on the spikelets of the grasses and sedges.
Gonophore : an elongation of the axis of a flower bearing the stamens and carpels.
Gonous : a suffix indicating an angled body, *e.g.*, trigonous, 3-angled.
Gymnosperms : plants having naked seeds, *i.e.*, seeds not enclosed in an ovary, such as in the pines.
Gynandrophore : same as gonophore.
Gynandrous : the stamens adnate to or borne on the pistil.
Gynobasic : applied to a style arising from the base of the carpels.
Gynoecium : the entire female part of a flower.
Gynophore : an elongation of the axis forming a stalk to the ovary.

H

Habit : the general appearance of a plant.
Habitat : the kind of locality in which the plant grows.
Hairy : clothed with somewhat long, not very dense hairs.
Hastate : spear-shaped or shaped like the head of a halberd ; with 2 acute basal lobes turned outwards.
Helicoid : coiled like a snail-shell : applied to an inflorescence which is more or less coiled with all the flowers on one side.
Herbaceous : applied to plants which do not form a persistent woody stem.
Hermaphrodite : with the flowers bisexual.
Heterogamous : when male, female, bisexual, and neuter flowers or any two or three of these are borne in the same flower-head.
Heterophyllous : having differently shaped leaves on the same plant.
Hilum : the scar left on a seed at the former point of attachment.
Hirsute : bearing long and somewhat stiff hairs.
Hispid : with rough or bristly hairs.
Homogamous : bearing only one kind of flowers.
Homogeneous : all of the same kind.
Hypocrateriform : salver-shaped ; said of a corolla with slender cylindrical tube and flat horizontally expanded limb.
Hypogynous : free from but inserted below the pistil.

I

Imbricate : overlapping.
Imparipinnate : pinnate with an odd terminal member.
Imperfect : where certain parts usually present are not developed, *e.g.*, when one sex is absent in a flower.

Incised : deeply cut.
Incumbent : resting or leaning upon.
Indefinite : too many to be readily counted ; applied to stamens when exceeding 20.
Indehiscent : not opening by valves or pores.
Indumentum : a covering, such as of hairs, scales, etc.
Induplicate : with the edges folded inwards.
Indurated : hardened.
Inferior : an inferior calyx, stamens, etc., implies insertion at a level below, or near the base of the ovary, and inferior ovary implies that the sepals, stamens, etc., are inserted on the torus at a level above or near the top of the ovary.
Inflorescence : the arrangement of the flowers on the floral axis ; the flower clusters as a whole.
Innovation : a new-formed shoot.
Integument : the covering of an organ or body.
Internode : the portion of an axis between two adjacent nodes.
Interpetiolar : between two opposite petioles.
Intrapetiolar : within the petiole, or between it and the stem.
Introrse : applied to anthers which open towards the pistil and not towards the circumference of the flower.
Involucre : a whorl of bracts surrounding several, rarely 1, flowers or their supports.
Involute : rolled inward.
Irregular : symmetric only on either side of a median plane.
Isomerous : having the members of successive series in equal numbers.

K

Keel : *(i)* a ridge like the keel of a boat, *(ii)* the two anterior, usually more or less united petals of a papilionaceous corolla.

L

Labiate : lipped, *i.e.*, divided at the apex to shape like lips, usually 2.
Lacerate : irregularly cleft as if torn.
Laciniate : irregularly cut into narrow lobes.
Lamella : a thin plate.
Lamina : the blade of a leaf.
Lanceolate : shaped like a lance-head ; narrowly ovate and tapering to both ends.
Lateral : situated to the right and left of the median plane.
Latex : milky juice.
Legume : a pod. A fruit from a single carpel opening by both sutures when ripe.
Leguminous : resembling the peas and beans, especially in the nature of the fruit.
Lenticel : Lens-shaped, sometimes elongate, small lenticular corky spots on young bark.
Ligulate : furnished with a ligule.
Ligule : a strap-shaped organ ; in grasses and some sedges a narrow transverse appendage at the base of the leaf within.
Limb : the expanded part of a corolla, petal, etc., in contradistinction to the tube or claw.
Linear : several times longer than wide.
Lip : one of the two divisions of a bilabiate calyx or corolla.
Lobe : any division of an organ, or specially a rounded division or projection.
Lobulate : having minute lobes.

-Locular : used in composition to indicate the number, etc., of cells or compartments in an ovary or fruit or in a ripe anther just before dehiscence.

Locule : a cell.

Loculicidal : applied to fruits which open by the dorsal sutures of the carpels.

Lodicules : minute scales at the base of the ovary of grasses, representing the perianth.

Lorate : strap-shaped.

Lunate : crescent or halfmoon-shaped.

Lyrate : applied to a pinnatifid leaf with the terminal lobe rounded and much larger than the lower ones.

M

Marcescent : withering without falling off.

Mericarp : a portion of a fruit which splits away and simulates a perfect fruit.

-Merous : a suffix used in combination to indicate the number of the parts, *e.g.*, trimerous, in threes.

Mesocarp : the middle layer of a pericarp.

Micropyle : the canal through the integuments of an ovule at the apex of the nucellus.

Mitriform : mitre-shaped.

Mon-, mono- : (prefix) one, alone, single.

Monadelphous : stamens which are more or less united into one bundle by the filaments.

Monochlamydeous : with only one whorl of the perianth.

Moniliform : resembling a string of beads.

Monocotyledons : plants of the class distinguished by having only one cotyledon.

Monoecious : with the male and female parts in different flowers but on the same individual plant.

Mucronate : tipped with a very short, hard, usually blunt point. If the point is longer or acute it becomes cuspidate or awned.

Multifid : cleft into many lobes or segments.

Muricate : rough with short, hard, tubercular excrescences.

-Nate : a suffix used in combination to indicate the number of parts, *e.g.*, binate, in pairs ; ternate, in threes.

Nectary : an organs in which nectar is excreted ; sometimes applied to any anomalous part of a flower, such as a spurred petal.

Nerve : a simple or unbranched vein or slender rib.

Node : that part of the stem which normally bears a leaf or a whorl of leaves.

Nut : a hard, dry, indehiscent, 1-seeded fruit, often also applied to a similar single part of a several-celled fruit.

Nutlet : a small nut.

O

Ob- : used as a prefix inverts the term affixed. Thus an ovate leaf has the wider part towards the base, an obovate leaf is inversely ovate and has the wider part towards the apex.

Obcordate : heart-shaped, but with the notch at the apex.

Oblique : when referring to shape means with one half more largely developed than the other.

Oblong : longer than broad and with the sides more or less parallel.

Obsolete : not developed.

Obtuse : blunt but scarcely rounded.

Ochrea : tube formed round the stem by the stipules as in Polygonaceae.

Ochreate : having ochrea.

-Oid : a suffix indicating similarity to the term prefixed, *e.g.*, pataloid, resembling petals.

Operculate : furnished with a lid.

Operculum : a lid or cover which separates by transverse dehiscence.

Opposite : said of leaves found in pairs at the nodes one on either side of the stem.

Orbicular : circular in outline.

Orthotropous : an ovule with a straight axis, the chalaza close to the hilum and the orifice at the opposite end.

Oval : broadly elliptical.

Ovary : that part of the pistil which contains the ovules.

Ovate : egg-shaped, with the broader part at the base.

Ovate-lanceolate, ovate-oblong, etc. : between ovate and lanceolate, between ovate and oblong, etc.

Ovule : the incipient seed before fertilization.

P

Pale, Palea : chaffy or hyaline scales present in the flowers of some plants.

Palmate : diverging like the widely spreading fingers of a hand.

Palmatifid : palmate with the sinuses reaching about halfway down.

Palmatipartite : palmate with the sinuses reaching beyond the middle.

Palmatisect : much cut in a palmate manner.

Palminerved : with the primary nerves radiating from the apex of the petiole.

Panicle: a loose compound inflorescence with usually the main axis racemose, the secondary and tertiary axes racemose or not.

Papilionaceous : shaped somewhat like the flowers of a pea or bean. A typical papilionaceous flower has a corolla with a large posterior petal (standard), two lateral petals (alae, wings), and two anterior petals more or less combined into a keel.

Papilla : a soft superficial protuberance or gland.

Papillose : covered with papillae.

Pappose : furnished with pappus.

Pappus : various tufts of hairs on some achenes or fruits, especially the scaly, bristly, hairy or feathery modified calyx in the Compositae .

Parallel-nerved : with numerous nerves from the base running more or less parallel and close to one another, as in the leaves of bamboo, etc.

Parasitic : growing upon and drawing sustenance from the living tissues of other plants.

Parietal : borne on or belonging to a wall ; applied to a placenta arising from the wall of the ovary.

Paripinnate : pinnate with an equal number of members on each side of the axis and no odd terminal one.

-Partite : a suffix denoting division deeper than to the middle.

Pectinate : pinnately cut in narrow segments set close like the teeth of a comb.

Pedate : palmately divided with the lateral divisions 2-cleft.

Pedatipartite : with pedate venation and the lobes nearly free.

Pedicel : the stalk of a single flower.

Pedicellate : possessing a pedicel.

Peduncle : the common stalk of 2-many flowers or of a complete inflorescence.

Pedunculate : furnished with a peduncle.

Pellucid : translucent or transparent.

Peltate : shield-shaped ; said of leaves of which the petiole is attached to the lower surface of the blade and not at the margin.

Pendent : pendulous, hanging down.

Penicillate : shaped like an artist's brush, with a terminal tuft of hairs.

Penninerved : with one midrib and secondary nerves branching from it.

Pentamerous : with 5 members in each whorl.

Perennial : a plant which lives for several years, not dying after flowering and fruiting once.

Perfect : an organ or a flower in which all the normal parts are present.

Perforate : pierced through or having translucent dots which look like little holes.

Perianth : the floral envelopes, calyx and corolla both ; a term mainly used when there is little or no difference in size and appearance between the sepals and petals.

Pericarp : the whole wall of the fruit.

Perigynous : said of the floral parts other than the pistil when they are inserted above the level of the base of the ovary, but not above the ovary.

Persistent : remaining attached until the part bearing it is wholly matured.

Petal : a single member of the corolla.

Petaloid : resembling petals.

Petiolate : furnished with a petiole.

Petiole : the stalk of a leaf.

Petiolule : the stalk of a leaflet in a compound leaf.

Phanerogams : plants with manifest flowers as opposed to cryptogams.

Phylloclade : a branch compressed so as to resemble a leaf and performing the functions of a leaf.

Phyllode : a petiole assuming the form and function of leaf.

Pilose : hairy with rather long, soft, distinct hairs.

Pinna : the primary division of a compound leaf when itself divided into leaflets.

Pinnate : organs or leaflets arranged on each side of a common axis as in a feather.

Pinnatifid : deeply lobed to about halfway down or more with the lobes pinnately arranged.

Pinnatipartite : pinnately parted.

Pinnatisect : pinnatifid down to the midrib.

Pinnule : the secondary division of a compound leaf when itself divided into leaflets.

Pistil : the complete female part of a flower.

Pistillode : a rudimentary pistil.

Placenta : the part of the ovary that bears the ovules.

Placentation : position of the placenta.

Plicate : folded into plaits, usually lengthwise.

Plumose : feathery or feathered.

Plumule : the primary leaf-bud of an embryo.

Pod : typically a dry fruit derived from a monocarpellary ovary, elongated in shape and dehiscing along one or both sutures, such as a pea-pod. In a more extended sense any fruit of the Leguminosae family or other fruit resembling a typical leguminous fruit.

Pollen : the fertilizing powdery, granular or waxy bodies produced in the anthers.

Pollinium : a pollen mass.

Poly- : a prefix indicating the presence of many of the affixed objects.

Polyadelphous : in many bundles.

Polycarpellary : applied to a pistil formed of several carpels, free or united.

Polyandrous : having an indefinite number of stamens.

Polygamous : with both bisexual and unisexual flowers borne by the same species on one or on different individuals.

Polymorphic : variable as to shape or habit.

Polypetalous : having separate petals.

Polysepalous : having separate sepals.

Pome : a fruit like an apple ; a succulent inferior many-celled fruit. the seeds in dry cells with tough and hard lining ; a drupe with cartilaginous endocarp.

Posterior : *see* under Anterior.

Prickle : a pointed spine-like process originating from the epidermal, or epidermal and subjacent, tissue only.

Procumbent : lying along the ground.

Prostrate : when they lie close to the ground.

Puberulous : slightly hairy with very short hairs.

Pubescent : clothed with soft, rather short hairs or down.

Pulvinus : an enlargement close to the insertion of a leaf or the swollen base of the petiole.

Punctate : marked with dots, depressions or glands.

Pyriform : pear-shaped.

R

Raceme : an (indefinite or centripetal) inflorescence in which the main axis continues to grow and bears equally pedicellate flowers, the lowest flowers being the oldest opening first.

Racemose : bearing racemes or raceme-like.

Rachilla : the axis of the spikelet of grasses or sedges.

Rachis : the prolongation of the petiole in a pinnate leaf or the prolongation of the peduncle of an inflorescence ; often loosely used to include the petiole or the peduncle as the case may be.

Radiant : when the flowers on the outer rim of an umbel are larger than the inner.

Radical : arising from the root or its crown.

Radicle : the rudimentary root of the embryo.

Raphe : the ridge formed by the adherent funicle along the side of some ovules.

Ray florets or ray flowers : the more or less zygomorphic flowers found at the circumference of the heads in Compositae.

Receptacle : the portion of the axis of a flower that bears the sepals, petals, stamens, and pistil ; the short axis bearing the flowers in Compositae.

Regular : symmetrical in several planes.

Reniform : kidney-shaped.

Repand : with a wavy margin, but the sinuses more shallow than in sinuate.

Replum : a partition of the ovary which is not a part of the carpels. A septum joining the sutures of the two carpels in Cruciferae and some other families, from which the carpels or valves finally separate.

Reticulate : resembling network.

Retrorse : directed backwards or downwards.

Retuse : a shallow notch in a rounded apex, the sinus being less deep than in emarginate.

Revolute : rolled back from the margins or apex so that the upper face is outside.

Rhizome : an underground stem, usually horizontal and elongated.

Rhomboid : approaching a rhombic outline ; quadrangular with the lateral angles obtuse.

Rostrate : beaked with a slender tip.

Rosulate : with clustered leaves collected into a rosette.

Rotate : wheel-shaped ; said of a gamopetalous corolla with a short tube and spreading limb.

Rotund : roundish, not angular.

Rugose : thrown into wrinkles.
Rugulose : somewhat wrinkled.
Ruminate : said of a seed with the testa projected as points and plates into the albumen.
Runcinate : incised with the teeth or lobes directed backwards.
Runner : an elongated lateral shoot rooting at intervals, often dying off at the internodes.

S

Saccate : bulged into a small sac or cavity, as the short spur of some petals.
Sagittate : arrowhead-shaped with the base enlarged into two straight, acute lobes.
Salver-shaped : with a long tube and horizontally spreading limb.
Samara : an indehiscent winged fruit, or winged parts of a dehiscing fruit.
Saprophytic : feeding on decayed organic matter, such as humus.
Sarmentose : producing long arching slender branches.
Scabrid : covered with small hard hairs or points so as to feel rough to the touch.
Scabrous : very scabrid.
Scandent : climbing.
Scape : a leafless, or at most 1-leaved, floral axis or peduncle arising directly from the root.
Scapigerous : scape-bearing.
Scarious : thin, dry and membranous, not green.
Schizocarp : a fruit which splits up into two or more distinct portions (mericarps, cocci, etc.) each with its own wall.
Scorpioid : said of an inflorescence with flowers in 2 ranks and the axis coiled like the tail of a scorpion.
-Sect : suffix used to denote division of an organ to its base or nearly so.
Secund : with the parts or members all directed to one side.
Seed : the fertilized and matured ovule.
Sepal : a single member of the calyx.
Sepaloid : green and resembling a sepal in texture rather than a petal.
Septicidal : when a capsule dehisces through the dissepiments or lines of junction.
Septifragal : when the valves in dehiscence break away from the dissepiments.
Septum : any kind of interior wall or partition.
Seriate : arranged in rows either transverse or longitudinal.
Sericeous : clothed with silky adpressed hairs.
Serrate : toothed like a saw with the teeth directed forwards.
Serrulate : serrate but with the teeth very minute.
Sessile : without a stalk.
Seta : a bristle or long, stiff, needle-like hair.
Setaceous : bristle-like, more slender than subulate.
Setose : beset with setae.
Silicula : a short siliqua, not much longer than broad.
Siliqua : a fruit with two valves falling away from a frame on which the seeds are attached and across which a false partition is formed.
Silky : sericeous, covered with very fine adpressed silky hairs.
Simple : not composed of a number of similar parts, opposed to compound. A leaf is simple even if segmented provided that the divisions are not separated by portions of the axis destitute of blade.
Sinuate : with a deeply wavy margin.
Sinus : a recess or re-entering angle.

Spadix : a flower spike with a fleshy axis and usually enclosed when young in a spathe.

Spathe : a more or less modified bract enclosing or subtending a flower-cluster or complete inflorescence.

Spathulate : narrowly oblong with the end expanded and broader, more or less like a chemist's spatula.

Spicate : spiked, with the flowers in a spike.

Spike : an inflorescence with sessile flowers on a usually elongate axis.

Spikelet : a cluster of 1 or more flowers each in the axil of one or a pair of bracts and subtended by 2, rarely 1, empty bracts.

Spinulose : bearing small spines.

Spur : a hollow, or sometimes solid, extension of some part of a flower.

Stamen : the floral organ bearing the anther and pollen.

Staminal : relating to the stamens.

Staminode : a sterile or abortive stamen without pollen.

Standard : the large posterior and usually the most conspicuous petal of a papilionaceous corolla.

Stellate : with its parts radiating like the points of a conventional star.

Sterile : barren ; devoid of one or other of the sexual parts.

Stigma : that part of the pistil which receives the pollen.

Stigmatose : relating to the stigma.

Stipe : the stalk or support of an ovary or carpel.

Stipel : an appendage of a leaflet corresponding to the stipule of a leaf.

Stipellate : furnished with stipels.

Stipular : relating to stipules.

Stipulate : bearing stipules.

Stipule : one of a pair of appendages borne on each side of the base of the leaves or petioles of many plants.

Stolon : a sucker ; any basal branch that is disposed to form roots.

Stoloniferous : sending out or propagating itself by stolons.

Striate : marked with longitudinal, parallel, fine lines or minute furrows.

Strigose : beset with sharp-pointed, appressed straight, stiff hairs.

Style : the usually attenuated part of a pistil or carpel between the ovary and the stigma.

Sub-: a prefix used to denote somewhat, almost or under.

Subulate : awal-shaped ; slender, terete, and tapering to a sharp tip.

Suckers : (*i*) young plants formed at the end of creeping, underground rootstocks, (*ii*) plants formed from adventitious root-buds.

Succulent : soft and juicy.

Suffrutescent : low somewhat woody and branching near the ground.

Suffruticose : forming an undershrub.

Sulcate : grooved or furrowed.

Superior : situated above another member. A superior ovary has its base above the insertion of the calyx ; a superior calyx is inserted at a level above the top of the ovary.

Suture : a junction or seam of union ; line of opening.

Syncarpous : composed of 2 or more united carpels.

Synonym : a superseded or unused name.

T

Tendril : a filiform sensitive organ which winds round supports to enable weak stems to reach the light. Tendrils are of various morphological origin in different groups. Some may be modified branches, others leaves, another the end of a leaf rachis, etc.

Tepal : a division of a perianth, usually employed when there is no distinction between the 2 series.

Terete : cylindrical and circular in cross section.

Ternate : in groups of 3. A leaf with 3 leaflets is sometimes said to be ternate, but in this case it is really the leaflets which are ternate and the leaf is 3-foliolate .

Testa : the outer coat of a seed.

Tetradynamous : with 4 long and 2 short stamens.

Tetramerous : said of the flower when there are four members in each whorl.

Thalamus : *see* receptacle.

Throat : the orifice of a gamopetalous corolla or a gamosepalous calyx.

Thyrsus : a contracted or ovate panicle.

Thyrsoid : resembling a thyrsus.

Tomentose : densely covered with short soft tangled hairs.

Tomentum : pubescence.

Torus : that portion of the axis of a flower on which its parts are inserted.

Trichotomous : an axis successively 3-forked.

Trifoliolate : with three leaflets.

Trigonous : 3-angled.

Trilocular : 3-celled.

Trimerous : said of the flower when there are 3 members in each whorl.

Tripinnate : with the primary axis of the leaf pinnate with one or more pairs of the pinnae again pinnate and with one or more pairs of the secondary pinnae pinnate.

Triquetrous : 3-edged with salient angles.

Truncate : ending abruptly as if the end had been cut off.

Tuber : the thickened portion of an underground stem, *e.g.*, potato.

Tuberous : producing tubers, or resembling a tuber.

Turbinate : top-shaped.

Turgid : swollen, but not with air.

U

Umbel : an inflorescence in which a cluster of pedicels radiate from the top of a common peduncle and are of the same length.

Unarmed : without thorns or prickles.

Undulate : wavy.

Unilateral : arranged on one side of the axis.

Unilocular : applied to an ovary not divided up by partitions into seperate compartments.

Urceolate : urn or pitcher-shaped.

Utricle : a membranous sac, or a bladder-like appendage.

V

Vaginate : sheathed or sheathing.

Valvate : opening by valves ; or the several parts of an organ which meet exactly without overlapping.

Vascular : relating to or furnished with vessels.

Vein : the branch of a nerve.

Ventral : the front side, the side towards the axis

Verrucose : warty.

Versatile : turning freely on its support; said of anthers attached above the base and swinging freely on the acute tip of the filament.

Villous : covered with long, weak hairs.

Vittae : the aromatic oil tubes of the pericarp of most Umbelliferae.

W

Whorl : the arrangement of organs in a circle round an axis.

Wings : the side petals of a papilionaceous flower.

X

Xerophilous : growing in arid places.

Xerophyte : a plant which can subsist naturally in dry hot places.

Z

Zygomorphic : capable of being bisected into two similar halves by only one plane, bilaterally symmetrical.

POISONOUS PLANTS OF INDIA

INTRODUCTION

I.—GENERAL CONSIDERATIONS

1.—Meteorological conditions

India presents a greater variety of meteorological conditions and features than perhaps any other area of similar size in the world, and furnishes the typical large-scale example of the alternation of seasons known as the monsoons. It has been rightly described as a land of contrasts. During the winter third of the year the general flow of the surface air strata is from land to sea and thence over the Indian seas as a north-east monsoon; it is a season of winds of continental origin and great dryness. The summer third of the year brings a complete reversal of this condition, in a flow from sea to land of the moist winds of the south-west monsoon, which consequently is a season of much humidity, clouds, and frequent rain. Between these principal seasons of the year are the transitional periods of the hot-weather months, April and May, and of the retreating south-west monsoon, October and November. Rainfall, with which is associated the humidity of the atmosphere, and which more than any other meteorological condition exercises an influence on the vegetation, varies from about 430 inches at Cherrapunji in the hills of Assam to the north-east of the Bay of Bengal, and from about 350 inches in certain portions of the Western Ghats to as little as 5 inches or less per annum in the desert areas of Rajputana in the north-west. During the south-west monsoon, from June to September, the air is supersaturated with moisture in the coastal districts and in the hills, while during the dry weather it may in certain districts be so dry as to defy the ordinary methods of calculation for humidity. The hill stations in the Himalayas may be shrouded in clouds for days together in September with humidities of 100 per cent, while in November may be overrun with air of practically zero humidity. No less striking is the contrast exhibited by temperature; that at Jacobabad in upper Sind has several times registered 126°F. and over, while the observatory at Dras in Kashmir has recorded a temperature as low as — 49°F. Arctic conditions prevail throughout the year in some of the Himalayan and Trans-Himalayan ranges. The mean annual range

Seasons

Rainfall

Humidity

Temperature

of temperature at Cochin in South India, 20°F., is less than the daily range at many stations in Northern India and only about one third of their annual range.

2.—Topography

The physical features of the country also present a variety probably unrivalled by any other area of similar size on the globe, and next to its climate exercise the most important influence in determining its vegetation. In the north, extending from Assam to Kashmir and running in a general north-westerly direction, lies the loftiest and most massive range of mountains in the world, the Himalayas, with one of its peaks, Mount Everest, rising to 29,002 ft. above sea level. This is separated from the Peninsular India proper by the Indo-Gangetic depression, a broad belt of country through which in the west the Indus and its tributaries drain in a south-westerly direction to the Arabian Sea, while at no great distance from the source of this system, the Ganges takes its birth to drain the great fertile plains of North-East India comprising the United Provinces, Bihar, and Bengal.

India south of the Indo-Gangetic depression is characterized by a backbone of mountains in the west, known as the Western Ghats, which run more or less parallel to and at no great distance from the coast of the Arabian Sea; on the north by the Aravalli range and the rising uplands of Central India and Chota Nagpur, and on the east by the range known as the Eastern Ghats. Roughly these bound and contain the great central plateau which is itself intersected mainly from a westerly to an easterly direction by the water system of the Godavari and Krishna and minor streams draining into the Bay of Bengal. To the south of the peninsula the Ghats taper off in the Nilgiris and Cardamom Hills to gentle smooth rounded slopes of green uplands. Between the Ghats and the sea there is a comparatively narrow flat or gently sloping belt.

3.—Vegetation

General remarks

Spread over an area of 1,575,107 square miles, and endowed by nature with a wide variety of physical and climatological conditions, India possesses what is perhaps the richest and certainly the most varied flora of all other areas of a similar size on the surface of the globe. For the purpose of this monograph, it is only necessary to point out briefly certain outstanding features which will give a broad idea of the vegetation in different parts of the country. For greater details, the reader is referred to the accounts of the Indian vegetation by Hooker (*1*) and by Calder (*2*), and in several provincial, local, and other floras

which preceded or followed the publication of "The Flora of British India".

Culturable land

India has a total area of culturable land of about 450 million acres, excluding a forest area of 83 million acres, of which the total gross cropped area sown each year approximates to 285 million acres. The forest vegetation of India consists of the following different types: (*a*) the evergreen forests occupying the Western Ghats and the lower slopes of the Eastern Himalayas with their magnificent and majestic trees, the "sky scrapers", which, together with a plentiful supply of bamboos in these forests, are features of great economic value to India; (*b*) the deciduous type of forests, covering a large part of the peninsula, which are very important to the country containing as they do a large number of the more important timber trees; (*c*) the dry forests of Rajputana and the Punjab which become drier and drier towards the west and south-west and disappear into the desert on both sides of the lower Indus where the courses of perennial rivers alone are fringed by a belt of arboreous vegetation; (*d*) the hill forests of the Himalayas; and (*e*) the mangrove forests which are found on many tidal creeks and backwaters along the coasts of India, chiefly in the deltas of rivers, such as the Sundarbans. Aquatic or semi-aquatic type of vegetation is met with in the tanks, jhils, ponds, watercourses, and swamps all over India, particularly in Bengal. A striking feature with regard to the Indian vegetation is that in one season of the year vast areas in the plains are the scene of plenty for man and animals; in another they become a dreary brown sunburnt waste where herbivores starve by the thousands and where it passes human understanding how any creature dependent on vegetation can survive the dry season.

Forests

Fresh-water vegetation

Seasons of plenty and scarcity

Himalayas

The massive chain of the Himalayas in the north is a tumbled mass of hills and valleys, and is covered with a vegetation which is richer and more varied than that of any other part of India if not the world. It is in this chain that the highest limit of vegetable life on earth has been recorded. Three distinct types of vegetation, *i.e.*, a tropical, temperate, and an alpine, roughly corresponding to altitudinal zones, are recognizable on the Himalayas. It must be understood, however, that there is no hard and fast demarcation between them; plants of tropical zone intruding into the temperate zone and *vice versa*, and so with the temperate and alpine zones. The flora of the Eastern Himalayas differs remarkably from that of the Western Himalayas, the former being markedly richer both in the number of species and the individuals as well as in the epiphytic vegetation; the details also differ a good deal. Sikkim in the Eastern Himalayas, with rich arboreal vegetation and an abundance of climbers, etc., in its tropical belt, is the most humid

district in the whole range. The tropical type of flora vanishes rapidly as the extreme north-west portion of the Western Himalayas is reached. The temperate zone of the Western Himalayas is more hospitable to conifers than the Eastern. The tree limit in the Western Himalayas roughly corresponds to the perpetual snow line, *i.e.*, 12,000 ft. above sea level, the birch (*Betula*) which furnishes the well-known 'bhojpatra' paper from its bark reaching the highest limit. The alpine grasslands are remarkable for the variety of beautiful coloured flowers emitting pleasing odours and leading a short but glorious existence in the face of the exigencies of climate at altitudes above 12,000 ft. Vast areas at higher altitudes form the "alpine deserts" with little or no vegetation of any kind on account of the peculiar edaphic and climatological conditions prevailing there.

Indo-Gangetic depression

The Indo-Gangetic depression, drained by the Indus and the Ganges and their tributaries, presents great extremes of conditions for plant life. From a wide sun-scorched desert in the west where extremely hostile conditions for plant life exist, one passes along by gradation to the ever-green delta of the Ganges on the east, over a thousand miles distant. The vegetation of this area can best be considered under the following subareas :—

Indus Plain

The Indus Plain area includes the North-West Frontier Province, the Punjab, Sind and Rajputana west of the Aravalli range and Jumna river, Cutch and Gujerat. This area is traversed by a number of great rivers, the tributaries of the Indus, and a rich canal system. The best known amongst the most modern Indian canal systems are those of the Punjab and Sind canal colonies where rainfall is insufficient to mature any crop without irrigation and where land has literally been reclaimed from the desert and converted into fertile arable land; towards the south-east, however, canal irrigation only supplements the natural rainfall. By far the largest portion of this area is a more or less level ground, which is poorly covered with vegetation owing to the dryness of the climate. From Jhelum northwards the plains are thrown up into small "pits and mounds".

The forests in this area are generally stunted and tend more to scrub, except where irrigation allows of their development, towards lower altitudes of the Himalayas, and on the slopes of the Aravalli range. Saline tracts characterize the plains over wide areas; these are recognized by their peculiar polished appearance. The presence of the 'lunakh' grass (*Sporobolus arabicus* Boiss.) and of such plants as *Salsola foetida* Delile and *Suaeda fruticosa* Forsk. in large numbers is a sure botanical evidence of the salinity of the soil. The increase in irrigation in this area has, however, greatly affected the natural flora and is rapidly

creating conditions for the extinction of the original formations. In the moister parts and on the irrigated portions of the plain, the Sub-Himalayan plants are extending their range. Compared to the Western Himalayas the vegetation of this area is poor. A traveller proceeding across the area in a south-west direction from the Himalayas to Sind or in a south-east direction from the Afghan border to Western Rajputana will witness a rapid decrease of the vegetation approaching extinction in the Great Indian Desert. The number of species in this area is about one third of that in the Western Himalayas ; there is a preponderance of the shrubby vegetation and of the annuals which can withstand prolonged periods of drought. The Indus delta is covered by the mangrove forests.

Gangetic Plain

The rest of the Indo-Gangetic depression is to a very great extent given over to cultivation and comprises the fertile plain of north-east India drained by the Ganges and its tributaries. The influence of man in search of more and more agriculturally exploitable land has greatly altered the original vegetation of this area, except the deltaic area of the Sundarbans. The indigenous vegetation of the western part of this area, or of the Upper Gangetic Plain, has marked affinities with that of Indus Plain, the middle Himalayas, and the adjoining areas of the Peninsular India ; it is that of a dry country having leafless trees and burnt-up herbs in the dry season, the cultivation increasing more and more towards the east. The rest of the area from Benares eastwards, including the plains of Assam watered by the Brahmaputra, but excluding the Sundarbans, is the "greenest" of all the plains of India with abundance of cultivated fields and fruit gardens. The tanks, jhils, ponds, watercourses, and swamps are rich in aquatic or semi-aquatic type of vegetation which attains its maximum here ; it is in this area that the comparatively recently introduced water hyacinth [*Eichhornia crassipes* (Mart.) Solms] has become a great menace by rapidly spreading and thus clogging the waterways, much to the disadvantage of its inhabitants. The Sundarbans or the deltaic region of the Ganges are clothed with the evergreen forests of the tidal or littoral type, which are more highly developed here than anywhere else in India on account of the saline soil of this area receiving a larger precipitation of the monsoon rains than any other mangrove forests in the country. Many of the trees here send up from their underground roots a number of pneumatophores or aerial roots for respiration; these appear like a small forest of tent pegs jutting out from the ground.

Peninsular India

The whole of the peninsular part of India south of the Indo-Gangetic depression is more or less under the influence of trade winds. On

account of its proximity to the ocean, there is less variation in temperatures; the climate is more equable and there is, comparatively, much less seasonal variation in the vegetation than is the case in more extreme conditions away from the sea or out of the way of the main monsoon routes. Between the Ghats and the sea the nature of vegetation is tropical, being much more scanty in the east than on the west except in the neighbourhood of river mouths.

Western Ghats

The humidity of the Western Ghats area expresses itself in a luxuriant tropical vegetation; its verdure reminding one of the eastern part of the Gangetic Plain and most deltaic regions, but there are loftier trees and more palms. It is botanically one of the richest areas in India.

Nilgiris and Pulneys

The Nilgiris rising up to 8,760 ft. above sea level and the Pulneys call for a special reference, not only because they are the highest ranges of hills in South India but also because the vegetation of these changes quite rapidly from the rich tropical and subtropical flora of the steep slopes to one of a more temperate and more herbaceous character about an altitude of 6,500 ft. These hills are characterized by undulating summits of grassy downs and tablelands which are much more extensive on the Nilgiris than on the Pulney hills. At and near the tops of these ranges, densely wooded often shallow gorges of evergreen forests locally called 'Sholas' are met with. The exotic Australian eucalypti and acacias strike every visitor to the Nilgiris and the Pulneys. Peat bogs, which are of the rarest occurrence in India, are found in the depressions of the Nilgiri Hills towards their summits.

Deccan

The rest of the Peninsular India, east of the Western Ghats, is sometimes known as the Deccan in an extended sense, and is characterized by a plateau of medium height. The rivers have eaten more or less broad sections out of the plateau and in these sections there are areas where cultivation has not disturbed the natural vegetation. The plateau terminates in the east in a low range of hills, the Eastern Ghats, between which and the sea the land falls more or less abruptly to what is known as the Coromandel Coast. Deciduous forests are the most conspicuous feature of the plateau and comparatively evergreen ones are found on the coasts and slopes with an eastern aspect. Much of the open country has small trees and shrubs, together with a herbaceous vegetation which is dried up and leafless in the dry season. The rich black cotton soil which extends over large areas in the Deccan deserves a special notice, as it is characterized by a peculiar assemblage of indigenous plants. The Northern Deccan is floristically linked with the temperate to subtropical floras of the Eastern and Western Himalayas, and is moist enough for some of the epiphytic orchids. The common annuals or perennials of the Gangetic Plain extend

Mysore, Carnatic, and Coromandel

considerably southwards into the Deccan. The vegetation in Mysore, with its wealth of the sandalwood forests, and in the Carnatic further south, is somewhat scanty with the tableland often barren and the hills at best covered with a low shrubby vegetation; towards the west where the influence of the monsoon is felt, the vegetation tends to be luxuriant and similar to that of the Western Ghats, and extensive forests are, therefore, found. The steep slopes of the Eastern Ghats, which come normally within the influence of the north-east monsoon, are also densely wooded. The Coromandel has a distinct flora and carries the Deccan types to the sea. Mangrove forests occur in the estuaries. The Western part of the Coromandel, bordering the outliers of the Eastern Ghats, abounds in thickets of thorny evergreen and deciduous trees and shrubs. Elsewhere it is hot, dry, and sandy without much vegetation. At its extreme southern end, in the exceptionally hot and arid plains of the Tinnevelly and Madura districts where the influence of monsoon is feeble, the vegetation is of a semi-desert nature.

Relationship to floras of other countries

Indian flora is closely related to that of some other countries, and it is interesting to remark that none of the families of flowering plants is peculiar to this country. There is a very great preponderance of those genera and species which are also found in the adjacent countries. Malayan, Burmese, and Chinese genera are specially well represented in Eastern India. Next in order come the European and the Middle East floras which are particularly strongly represented in Western India, and of the typically European elements there are twice as many in the Western as in the Eastern Himalayas. Nearly 600 European genera are represented in India, many of them, however, by a single species, and the Middle Eastern element is certainly, as is to be expected, no less prominent. African, Australian, and American elements follow these in decreasing proportions, the African flora being more noticeable in Western India. Recently there has been an influx of American species, which have a remarkable tendency to spread. Tibetan and Siberian floras only reach India in the alpine regions of the Himalayas, while the Chinese and Japanese elements are strongly represented in its temperate belts.

Number of plants and dominant groups

There are in the neighbourhood of 13,000 species of flowering plants found in India, and these are spread over about 170 families, the largest family being Gramineae. Next in order of dominance come the Orchidaceae, Leguminosae, Compositae, Rubiaceae, Cyperaceae, Acanthaceae, Euphorbiaceae, Labiatae, and Urticaceae. The low place of Compositae, the world's richest family of flowering plants, is remarkable. In most other countries it tops the list, but in India it comes fourth in the order of prevalence. Monocotyledons in this country are relatively important, there being one for every seven species of Dicotyledons.

Food and fodder plants

Medicinal plants

India abounds in all kinds of food plants, spices, oils, perfumes, timbers, fibres, gums, etc., which have been known all over the world from ancient times. There are more than 700 important food and fodder plants, including about 260 species of valuable fodder grasses. It is not surprising, therefore, that plants containing active and medicinal principles also grow abundantly within its bounds. More than 2,000 plants are alleged to have medicinal properties of some description or other and have been enumerated in the literature of indigenous medicine. Nearly three fourths of the drugs mentioned in the British and other Pharmacopoeias grow wild here, and others can be easily grown. Indeed, this country is a veritable emporium of drugs. The families to which the larger numbers of medicinal plants belong are : Leguminosae, Compositae, Labiatae, Euphorbiaceae, Rubiaceae, Rosaceae, Gramineae, Liliaceae, Rutaceae, Ranunculaceae, Umbelliferae, Cucurbitaceae, Solanaceae, Apocynaceae, and Malvaceae. Many of these medicinal plants contain chemical constituents which, if introduced into the body of an animal in relatively small quantities, act deleteriously and may cause serious impairment of bodily functions or even death. They injure the basic live principle, the protoplasm, of the cells of which the animal body is built up. They are ordinarily called poisonous plants, and apart from the utilization of their potent properties in the treatment of diseases to alleviate the sufferings of man and animals, there appears to be no doubt that they are a great menace in India through the poisoning of livestock and man. Recent studies by the authors have revealed that there are in India about 700 poisonous species belonging to over 90 families of flowering plants. The more important of these in their order of importance are : Ranunculaceae, Euphorbiaceae, Leguminosae, Solanaceae, Compositae, Apocynaceae, Asclepiadaceae, Ericaceae, Liliaceae, Gramineae, Araceae, Anacardiaceae, Thymelaeaceae, Rosaceae, and Rubiaceae. As in the case of medicinal plants, it does not mean that other families do not contain important poisonous plants. In fact there are several other families which have a few very potent species belonging to them. The list of the important families given above merely indicates that they contain the largest number of poisonous plants, so far as is known at present, with a further likelihood of containing plants with potent principles which are at present unknown.

Poisonous plants

II.—RELATIONSHIP OF PLANT AND ANIMAL LIFE

Plants manufacture food

There is a fundamental balance between animals and green plants. It is a common knowledge that animal life is directly or indirectly dependent on the vegetable kingdom for sustenance. In both plants and animals,

the protoplasm, the basic live principle, has not the capacity of being nourished by simple inorganic substances; it can only make use of complex organic compounds, such as carbohydrates, fats, proteins, etc., for building up its substance. The green plant whether "grass" or a diatom finds the raw material of its food in carbon dioxide, water, and dissolved salts, such as nitrates, sulphates, phosphates, etc. With the help of chlorophyll with which the green plants are provided, and the energy of the red-orange-yellow rays of the sunlight, they build up carbon dioxide and water into sugars and other carbon compounds, at the same time liberating oxygen as an all-important by-product so essential for life. This process is called carbon assimilation or photosynthesis and requires the presence of light and of chlorophyll, the sunlight supplying the energy and the chlorophyll the necessary apparatus to make use of this radiant energy. More complex substances are then elaborated. In the manufacture of proteins, they utilize the nitrates which are usually absorbed from the soil* in order to obtain a supply of nitrogen. Finally, these complex compounds are made use of by the protoplasm in building up its substance. This conversion of simple substances into complex nutritive compounds, which is possible only by the metabolism of the vegetable kingdom, is in marked contrast to the animal kingdom where no such constructive mechanism exists. The animals, therefore, entirely depend upon the vegetable kingdom for the supply of their food and life would be impossible without plants. Even when the animal is a thorough-going carnivore, a few links in the nutritive chain bring us back to green plants. All flesh is eventually "grass" and all fish is diatom. The synthesized nutritive compounds (carbohydrates, fats, proteins, etc.) produced by plants are abundant enough to sustain the animal world as well as the plants themselves.

Animal life dependent on plants

Production of toxic principles

By the metabolic activity of plants are produced not only the food materials so essential for life, but also certain other substances, such as alkaloids, glucosides, toxalbumins, essential oils, resins, bitter principles, etc. Many of these are harmful to animal life, at least under certain conditions, and the plants containing these principles which are capable of acting deleteriously are popularly known as poisonous plants. Many hypotheses, with arguments both for and against, have been advanced to explain the physiological significance of the toxic principles produced in plants. They have been thought to be (*a*) stages in the process of metabolism in the plant, (*b*) as waste products, and (*c*) produced in plants

Significance of toxic principles

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* Several plants of the family Leguminosae also derive nitrogen directly from the atmosphere by the action of bacteria which are present in the root-nodules of these plants and are known as the nitrogen-fixing bacteria. In the case of insectivorous plants, the supply of nitrogen is also obtained from their prey.

to protect them against being eaten by man and animal. It seems likely that one or more of these may be responsible for the production of toxic substances in plants, but the first-mentioned suggestion seems to be the most plausible and the last the least acceptable of the three.

Study of poisonous plants important

Whatever be the significance of toxic substances found in the vegetable kingdom, the fact must be remembered that they are associated with plants which manufacture food for man and animals, without which it would be impossible to live. The study of plants of any country with a view to assessing their harmful properties is, therefore, of prime importance, and increased knowledge in this direction and judicious utilization of the same is bound to be of immense benefit to its inhabitants.

III.—HISTORY OF POISONOUS PLANTS

1.—Ancient and medieval discoveries and uses

Accidental discoveries

Ancient uses

Procuring animal food

Primitive man in his quest for food must have come across plants containing poisonous substances, and by accident and by experience must soon have learnt to avoid them as articles of diet. He must have also soon begun to make use of them for his own purposes, for example, for procuring food for himself from the animal kingdom and to get rid of his enemies by their means. It is well known that even at the present time many of the forest-living tribesmen of India, numbering somewhere about 18 millions, use them to "fill their pot". Some of them have not been affected by civilization and, although they have started tilling the soil, they do not take kindly to agriculture but live chiefly by hunting wild animals with their bows and poisoned arrows. To catch fish they employ a number of plants which stupefy or kill them. There is no doubt that this mode of obtaining food has been practised by man from time immemorial. Indeed, the classic term "toxicology" is traced from the Greek word *toxikon*—meaning poison, originally the poison in which arrows were dipped, from *toxikos* of or for a bow, from *toxon* bow, arrow—which would indicate that the earlier use of poisons by the savage tribes of Eastern Europe was to smear such substances over arrows for killing.

Destroying enemies

Military expeditions into remote places in India even to this day have to guard themselves against the possible use of poisoned arrows. That man has used poisoning from very early times as the favourite means of taking life is amply supported by mythological and historical references, and it is said that much of the knowledge of the Western world regarding the poisonous plants was derived from the migrating nations of the East. The ancient Hindu scriptures contain references

to widespread poisoning in almost prehistoric times. Various methods were practised by the poisoners and Susruta in his work, about the date of which there is a great deal of uncertainty but which could not have been written later than 1,000 B.C., describes how the poisons were mixed with food and drink, anointing oils, perfumes, medicines, bathing water, snuff, or sprinkled over clothes, shoes, beds, jewellery, or put in the ear, eyes, etc. Wholesale poisoning was effected by a secret contamination of springs and wells. Selfishness, jealousy, revenge, and politics were undoubtedly at the bottom of all this ruthless poisoning of foes, relatives, and friends. Gradually there arose a class of "professional poisoners" who could ingeniously mask the bitter taste or strange odours of the poisons with sweet-tasting and pleasant substances. It had become necessary, therefore, for people to protect themselves against poisoning. In one of the Shastras (*Medicine of the Hindus*) translated by Wise, is written: "It is necessary for the practitioner to have a knowledge of the symptoms of the different poisons and their antidotes, as the enemies of the king, bad women and ungrateful servants, mix poison with food." Even poisons which produced loss of consciousness followed by recovery in some form or other were not unknown. "Bhoja-prahandha", a treatise written about 980 A.D., has a reference to the inhalation of medicaments before surgical operations, and an anaesthetic called 'sammohini' is said to have been used in the time of Buddha. Abortifacients were undoubtedly discovered very early in the history of India, and the present day extensive use of the narcotics 'dhatura' (*Datura* sp.) and 'bhang' (*Cannabis sativa* Linn.) in criminal practice dates back to the remote past. Mention of 'bhang' occurs in the Atharva Veda—the last of the four scriptures of the Hindus. This Veda reckons it along with the 'soma' as one of the five plants which were liberators of sin; and this would imply that its narcotic property was well known.

Medicinal uses

In addition to their uses for procuring animal food and destroying enemies, the poisonous plants were harnessed by the ancients for the amelioration of diseases. There is little doubt that the science of medicine became intimately connected with toxicology very early in the history of man. The earliest mention of the medicinal uses of plants can be traced to the Rig Veda, which is one of the oldest, if not the oldest, repositories of human knowledge, having been written between 4,500 and 1,600 B.C. It is, however, in the Ayurveda, which is considered as an Upaveda (or supplementary hymns designed for the more detailed instruction of mankind), that definite properties of drugs and their uses have been given in some detail. Ayurveda, in fact, is the very foundation-stone of the ancient medical science of India, and its age has been

fixed somewhere between 2,500 and 600 B.C. This work was followed by two works written later, *i.e.*, Susruta and Charaka; the seventh chapter of Charaka is taken up entirely with the consideration of purgatives and emetics. Charaka was written about the same period as Susruta, and from these two works various systems dealing with different branches of medicine in India sprang up.

2.—Decay of knowledge

There are unmistakable evidences that the knowledge of the ancient Hindus in toxicology and its related science, medicine, was more extensive and far in advance of others; it was at its zenith at the time of the conquests of Alexander the Great. During the invasions of India by the Greeks, Scythians, and Mohammedans successively, no original works were written and the existing literature was mutilated or lost. Degeneration became discernible everywhere, and with the advent of Europeans—first the Portuguese, then the French, and lastly the English—the decline became still further marked.

3.—Modern researches in toxicology

Investigations in foreign countries

The modern methods of investigation of poisonous plants had their birth in the Western countries. At the close of the eighteenth and in the beginning of the nineteenth century, chemistry had advanced sufficiently to make it possible to test arsenic and other important mineral poisons. The father of modern toxicology, however, was the distinguished French physiologist Orfila. He first showed that many poisons, notably arsenic, could be separated and determined in the ingesta and tissues of a poisoned subject, and also did much towards elucidation of the manner of absorption and distribution of a poison in the system. Orfila conducted actual experiments with different plants and in 1814 published his work which became the recognized authority on toxicology with special reference to the plant kingdom. Since his time various scientists have contributed to our knowledge of the poisonous plants. Very many plants have been investigated, their active principles isolated and characterized, and their actions on the animal organism have been studied. Of late the subject of poisonous plants has justly attracted an increasingly greater attention on account of its wide application, and a large volume of literature dealing with the poisonous plants of various countries has been published.

Investigations in India

The establishment of the British rule in India witnessed a period of recompilation and further investigation of the properties of Indian flora. Valuable information on a number of poisonous plants lies scattered in the works of many authors including Jones, Fleming, Ainslie,

Roxburgh, O'Shaughnessy, Moodeen Sheriff, Dymock and his collaborators, Watt, Kirtikar and Basu, and Chopra. Although many of these workers and others carried out laborious investigations, the pharmacology of most of the indigenous poisonous plants remained an unexplored field till recent years. Toxicology is intimately related to chemistry and experimental work on the pharmacological side can only be carried out in laboratories properly equipped with modern appliances. None of these were available in this country till the Calcutta School of Tropical Medicine was established in 1921. Then for the first time proper collaboration between botanists, chemists, and pharmacologists was rendered possible. Work on medicinal plants was thus started by the senior author and his colleagues. As a natural corollary to the study of medicinal plants, extensive investigations have recently been made by the present authors in the domain of poisonous plants of this vast country, for which there is no comprehensive and exclusive work available. Considerable gaps, however, still exist and more information is wanted about many well-known poisonous plants regarding which information is scanty, and in reference to innumerable representatives of the vegetable kingdom about which practically nothing is known.

IV.—DEFINITION OF A POISONOUS PLANT

1.—Popular definition defective

According to popular conception, a poisonous plant is one which will cause death or impairment of bodily functions, when taken in relatively small doses. This definition does not satisfy a critical mind in the light of modern researches as will be evident from the following :—

2.—Points to be borne in mind

Mechanically injurious plants excluded

1. The " seeds " of certain grasses notably of plants belonging to the genera *Stipa*, *Aristida*, *Heteropogon*, etc., may and do pierce the skin giving rise to subcutaneous or even intramuscular abscesses. Cases have also been reported where they have bored their way into the salivary ducts of the cattle and caused serious injury. The twisted and hygroscopic awns probably play an important part in this connection. The action is, however, purely mechanical and it would not be proper to designate the plants having this property as poisonous. Nor would it be desirable to include under this category, numerous spiniferous plants which do considerable harm to man and animals. The rigid, pointed, brown hairs of cowhage (*Mucuna prurita* Hook., syn. *M. pruriens*

Fl. Brit. Ind., *non* DC.), if touched, enter the skin and cause itching; taken internally they act as a mechanical irritant. Some animals, that are fed continuously on dry grasses rich in cellulose, develop in their stomachs and intestines plant-fibre-balls (phyto-bezoars) which lead to serious digestive disturbances and sometimes to fatal obstruction of the gastro-intestinal tract. All such plants prove injurious because of their mechanical action and cannot strictly be called poisonous. In contradistinction to the cowhage hairs, the hairs of stinging nettles, *e.g.*, species of *Urtica*, cause an itching sensation and urticaria, not by mechanical action but by a definite poisonous chemical constituent which is introduced into the body. Their action, therefore, belongs to a different category.

Some parts only may be toxic

2. All parts of the plant are not necessarily poisonous. The seeds of several members of the family Rosaceae contain dangerous amounts of prussic acid, while the outer fleshy portion of the fruit is commonly eaten, as in the case of peach [*Prunus persica* (Linn.) Stokes]. A part or parts of a plant may thus be poisonous while the rest may be innocuous or even wholesome.

Susceptibility varies

3. Sometimes it so happens that such quantities of a plant which are poisonous to one species of animal may not affect others. As an example may be mentioned belladonna (*Atropa belladonna* Linn.), which is highly poisonous to several animals, but certain rodents, such as rabbits, can withstand it in large quantities.

Only some organs may be affected

4. Some plants, if eaten, affect certain organ or organs of the body only. Although they do not cause immediate death or serious bodily harm, yet the organ or organs so affected are unable to carry on their normal functions and appreciably shorten life or produce a pathological condition. As an example may be mentioned certain species of *Senecio* of the sunflower family, which cause hepatic cirrhosis in man and animals, and prevent the liver from carrying on its normal functions.

Toxicity modified

5. Certain plants are poisonous to man and animals in the fresh state, but lose their toxicity on being dried or cooked, and are used as articles of food. As examples of these may be mentioned some of the yams (*Dioscorea* sp.) and aroids (Araceae). Species of the genus *Ranunculus* which, though toxic in the green state, can also be used as fodder when dried.

Occasional development of toxic substances

6. Several plants normally provide valuable food for animals, but under certain conditions produce varying amounts of poisonous substances which may be deadly. As an example may be mentioned potato (*Solanum tuberosum* Linn.) which is one of the most valuable vegetables,

but at the time of sprouting produces dangerous amounts of solanine. Several members of the family Gramineae in times of drought or during wilting are capable of liberating amounts of hydrocyanic acid which may be fatal, and have produced innumerable deaths among livestock all the world over. As an example may be mentioned the 'juar' or Guinea corn [*Sorghum vulgare* (Linn.) Pers.].

Toxic effects of prolonged feeding

7. Many plants, such as chickling vetch or 'khesari' (*Lathyrus sativus* Linn.), give rise to pathological conditions when fed in large doses over prolonged periods. This plant is normally eaten by man and livestock.

Deficiency diseases

8. The constant feeding of plants deficient in vitamins, minerals, proteins, etc., also leads to harmful results culminating occasionally in death.

Bacteria excluded

9. Bacteria are a class of unicellular plants acting independently of each other. The toxins (endotoxins or exotoxins) produced by them are responsible for various diseases in man and animals, but they are not generally classified as poisonous plants. A poison differs from a bacterial toxin in that a plant poison, as understood in this work, does not give rise on long-continued sublethal dosage to the production of antibodies or protective substances in the blood serum. This is an important distinction although phytotoxins of the castor seed (*Ricinus communis* Linn.), jequirity (*Abrus precatorius* Linn.), and the seeds of some species of *Croton*, though they originate from the living cell and give rise to antibodies, are not of bacterial origin, and are, therefore, included amongst poisons.

Some fungi excluded

10. Fungi, which are parasitic on man and animals and produce such diseases as ringworm, taenia versicolor, etc., are another group of plants which are not usually grouped amongst poisonous plants.

3.—Definition of a poisonous plant

No satisfactory definition available

It is evident that any scientific definition of a poisonous plant must be in terms which would embrace all plants that are deleterious to health and satisfy the above criteria. Various definitions have been given by workers interested in the subject, but none strictly satisfies all the conditions enumerated above. The following definition of a poisonous plant which the present authors have formulated is believed to answer the scientific requirements in the light of our present day knowledge :—

Authors' definition

A poisonous plant is one which, as a whole or a part thereof, under all or certain conditions, and in a manner and in amount likely to be taken or brought into contact with an organism, will exert harmful effects or cause death either immediately or by reason of cumulative action of the toxic

property, due to the presence of known or unknown chemical substances in it, and not by mechanical action.

Explanatory remarks

It will be seen from the foregoing paragraphs that this definition which includes such drastic poisonous plants as certain species of *Aconitum*, *Strychnos*, and several other plants used in medicine, also embraces such important food and fodder plants as potato and grasses. Indeed, some of our plants are at once poisons, medicines, food or fodder.

V.—TOXIC CONSTITUENTS OF PLANTS

General remarks

The poisonous properties of a plant, as has been pointed out, are due to the presence of certain toxic constituents. Before discussing other aspects of the subject it is desirable to give here a brief account of these substances. For details regarding the distribution of important toxic chemical constituents, the reader is referred to classified lists in the Appendix.

Our knowledge of the chemical constituents of plants has advanced rapidly in recent years, and the constituents responsible for the specific physiological action of the plant have in many cases been isolated, purified, and identified as definite chemical compounds. The pharmacological action of many of these has been studied by modern methods of assay and we are now in possession of a more exact knowledge of the action of the drugs containing these constituents. A good deal of work, however, has yet to be done in connection with the isolation and elucidation of the chemical nature of many other toxic or physiologically active constituents known to be present in various plants. Quite a large number of plants known or suspected to be toxic remain uninvestigated and this is particularly the case with the Indian flora.

Vegetable bases

1. An important group of compounds constitute the nitrogenous vegetable bases which include amines, purines, and alkaloids.

Amines

(i) The amines are known as the simpler natural bases and are mainly derived from amino acids, the building materials of all proteins. Some of the amines give a foetid odour to the plants in which they occur, and to some mushrooms their poisonous character. The simple amine, trimethylamine, which is otherwise harmless, is the cause of the peculiar odour of the flowers of hawthorn (*Crataegus oxyacantha* Linn.). The faecal odour of *Paederia foetida* Linn. is due to the presence of indole. The pressor action of the American mistletoe [*Phoradendron flavescens* (Pursh) Nutt.] is attributed to the presence of phenylethylamine, and active amines, such as *iso*amylamine, β-iminazolylethylamine, etc.,

have been isolated from ergot (*Claviceps purpurea* Tulasne). Several bacteria are also known to produce physiologically active amines when they act on the proteins of various foodstuffs, producing poisoning. Such amines are, however, comparatively rare among the higher plants.

Purines

(ii) The purines or methylxanthines form another class of nitrogenous compounds occurring as the active principles of some tropical plants, such as tea [*Camellia sinensis* (Linn.) Kuntze], coffee (*Coffea arabica* Linn.), cocoa (*Theobroma cacao* Linn.), kola (*Cola acuminata* Schott & Endl. and *C. vera* K. Schum.), guarana (*Paullinia cupana* H. B. & K.), etc. They are confined only to a few genera. The important representatives of these purines having some physiological action are caffeine, theobromine, theophylline, etc. The purines may be considered as the derivatives of a parent substance named *purin*, which on hydrogenation is converted into *purine*, $C_5H_4N_4$.

Alkaloids

(iii) The alkaloids form the most important group of vegetable bases. They are usually defined as complex heterocyclic nitrogenous compounds having a basic nature and are mostly tertiary amines. The base is usually more insoluble than the salts. They are found in plants in combination with various organic acids as salts, which make them more or less soluble in water. Some of the alkaloids are nontoxic, but as a class they are characterized by a profound physiological action, and in many cases by their intensely poisonous nature. As a rule, they have a bitter taste which is frequently, for the plants containing them, a sufficient protection against being eaten by livestock, except in unusual cases of hunger. They are, however, not of wide distribution in the vegetable kingdom. No alkaloids have been found in Algae, Liverworts, and Mosses, very few in Fungi, not many in Vascular Cryptogams and Gymnosperms, but more in Monocotyledons, while the vast majority of them have been reported from Dicotyledons. Among the Phanerogams again, they are restricted to a comparatively few families; those rich in plants containing alkaloids are: Ranunculaceae, Papaveraceae, Leguminosae, Rubiaceae, Apocynaceae, Solanaceae, Liliaceae, etc. Examples of typically toxic alkaloids are aconitine from aconite roots (species of *Aconitum*), morphine from poppy capsules (*Papaver somniferum* Linn.), emetine from ipecacuanha roots (*Psychotria ipecacuanha* Stokes), strychnine from nux-vomica seeds (*Strychnos nux-vomica* Linn.), nicotine from tobacco leaves (species of *Nicotiana*), coniine from the hemlock (*Conium maculatum* Linn.), and curarine from curare (*Strychnos toxifera* Schomb. *ex* Benth.).

Glucosides

2. The glucosides form a group of compounds which are perhaps more widely distributed in the vegetable kingdom than the alkaloids,

They are defined as compounds which when split up with the help of acids or enzymes yield a sugar or some closely allied carbohydrate and one or more of other products (usually phenols, aldehydes, alcohols or acids), known as "aglucones". Many do not contain nitrogen. Some modern authors designate these compounds as "glycosides" and restrict the name of "glucosides" to those only in which the sugar component is glucose; this distinction is not, however, being universally followed. The term glucoside has, therefore, been used throughout this work. According to the nature of the hydrolytic products, these glucosides are divided into various classes. Many of the glucosides are, however, nontoxic in nature, and we will confine ourselves only to those which are either directly toxic to man or animals or those which give rise to toxic components on hydrolysis.

Of the latter, the most important class comes under the term "cyanogenetic" glucosides. These glucosides, although by themselves more or less harmless, give rise to the most toxic acid, hydrocyanic acid. Examples of these cyanogenetic glucosides are amygdalin found in bitter almonds (*Prunus amygdalus* Batsch), phaseolunatin (linamarin) found in flax (*Linum usitatissimum* Linn.) and Lima or Duffin bean (*Phaseolus lunatus* Linn.), prunasin found in wild cherry (*Prunus*), gynocardin found in false chaulmoogra seeds (*Gynocardia odorata* R. Br.), sambunigrin found in the elder (*Sambucus nigra* Linn.), and so on. Of particular economic and toxicological interest is the occurrence of cyanogenetic glucosides in a number of grasses (Gramineae) which provide valuable fodder for livestock.

Other glucosides which may be said to yield somewhat harmful components on hydrolysis are sinigrin found in the black-mustard seeds [*Brassica nigra* (Linn.) Koch], sinalbin found in the white-mustard seeds (*Sinapis alba* Linn.), and so on. These yield essential oils containing various sulphur compounds which are irritant in their action.

Glucosides which may be said to have direct toxic action on animals are digitoxin found in *Digitalis*, cerberin found in *Cerbera*, strophanthin found in *Strophanthus*, thevetin found in *Thevetia*, paristyphnin found in *Paris*, antiarin found in *Antiaris*, and so on.

Saponins

3. The saponins form another class of compounds which occur in about 400 species belonging to 50 different families. Of the families discussed in the text, not less than 40 contain saponins, a few typical genera bearing saponins being *Sapindus*, *Entada*, *Barringtonia*, *Saponaria*, *Quillaja*, etc. Although they are regarded as a class of glucosides,

their peculiar properties and very wide distribution among numerous families make it necessary to consider them separately. The saponins produce a soapy foam on being shaken with water, whence they derive their name. They possess a bitter, acrid taste, and in the form of a dry powder are very irritating to the nose. They are particularly toxic to cold-blooded animals, such as fishes, frogs, insects, etc. Fishes are killed in such high dilution as 1 : 200,000. In warm-blooded animals, they often produce gastro-intestinal irritation, vomiting, and diarrhoea when taken by mouth. They produce haemolysis when they come in contact with blood. The more poisonous saponins are sometimes known as "sapotoxins". On hydrolysis they yield different sugars, generally hexoses and pentoses, and another component known as sapogenin, which is often physiologically active.

Bitter principles

4. The bitter principles, which are neutral and nonglucosidal in nature and possess a bitter taste, are found in a number of plants and are of common occurrence in the wild members of the Cucurbitaceae family. Preparations of several plants containing these are used in therapeutics to increase the appetite; some of these are also employed for their purgative properties. The bitter principles include the different aloe bitters, which are found in the inspissated juice of several species of *Aloe*; these possess a characteristic nauseous and bitter taste, and have a purgative action. Of the various aloe bitters, the most important are the aloins which are compounds of pentoses and hydroxyanthraquinone derivatives. Hydroxyanthraquinone derivatives are also present in different species of *Cassia*, *Rheum*, and *Rhamnus*. A number are lactones, *i.e.*, derived from alcohol acids by elimination of water. Santonin, a lactone found in some species of *Artemisia*, and picrotoxin from *Anamirta cocculus* (Linn.) Wight & Arn. are among other examples of compounds belonging to this group.

Toxic proteins

5. All the proteins are composed of various amino-acid units or their derivatives condensed together. The presence of toxic proteins, also known as toxalbumins, has been observed in the Leguminosae family in such genera as *Abrus* and *Cassia*, and in the Euphorbiaceae family in *Croton*, *Ricinus*, *Jatropha*, and *Hura*. Examples of he toxalbumins are abrin from *Abrus precatorius* Linn., crotin from *Croton tiglium* Linn., ricin from *Ricinus communis* Linn., and curcin from *Jatropha curcas* Linn. These toxalbumins are essentially blood poisons, and are characterized by their property of agglutinating and precipitating the red blood corpuscles. Animals can, however, become immune to these bodies if given in small and gradually increasing doses, but the immunity is of a specific nature, that is, against that particular toxalbumin and not against every one.

Fixed oils

6. The fixed oils are generally compounds of glycerol with different kinds of fatty acids containing sterols and other substances dissolved in them. They are greasy liquids occurring quite commonly in the seeds of plants. When heated, they decompose giving off acrid acrolein vapours. They are insoluble in water or glycerine, sparingly soluble in alcohol, and freely soluble in ether, chloroform, benzene, carbon disulphide, etc. They generally have laxative properties. Some of the fixed oils, however, have a drastic purgative action, *e.g.*, those obtained from *Croton tiglium* Linn., *C. oblongifolius* Roxb., *Jatropha curcas* Linn., *Ricinus communis* Linn., etc. The croton oil expressed from the seeds of *Croton tiglium* is the most violent of all cathartics; applied externally on the skin it produces irritation and pustulation. In some cases, such as that from *Ricinus communis*, the purgative action of the oil has been definitely traced to the presence of the glycerides of hydroxy acids, while in others, such as the oil from *Jatropha curcas* which does not contain any hydroxy acid, the action may be attributed to some other component dissolved in the glycerides. The other poisonous properties of some of these fixed oils are probably due to resinous or other toxic principles dissolved in these oils; for example, the vesicating action of croton oil is due to the resin dissolved in the oil.

Essential oils

7. The essential oils or volatile oils are the odorous principles which are generally responsible for the odour of plants in which they occur. They usually occur as such in plants, but in some cases they are found in a state of combination as glucosides from which they may be liberated by the interaction of enzymes, as is known to occur in some members of the family Cruciferae. The essential oils differ from the fixed oils by being volatile in steam. They are generally mixtures of different chemical compounds which may include hydrocarbons known as terpenes and sesquiterpenes, open-chain alcohols and aldehydes, aromatic alcohols of the camphor series and their ketones, aromatic alcohols of the benzene series and their aldehydes and ketones, sesquiterpene alcohols, phenols and their derivatives, esters of different alcohols, and sulphur compounds.

From the nature of their components, it may be expected that essential oils would act as antiseptics, disinfectants, insect repellents, and in some cases as insecticides. They possess a sharp burning taste and locally have an irritant action which is especially marked upon the mucous membranes. Large doses given internally produce a violent irritation of the entire gastro-intestinal tract, with consequent pain, vomiting, and diarrhoea. The hyperaemia may spread to the peritoneum and to all neighbouring parts, among others, in the female, to genital organs, where the congestion may find expression in haemorrhage and

abortion. This especially happens in the case of certain oils, such as those of juniper (*Juniperus communis* Linn.), savin (*J. sabina* Linn.), rue (*Ruta graveolens* Linn.), pennyroyal (*Mentha pulegium* Linn.), and parsley [*Petroselinum crispum* (Mill.) Nym. *ex auct.* Kew, syn. *P. sativum* Hoffm. and *Carum petroselinum* Benth. & Hook. *f.*]. Some of the essential oils, *e.g.*, that of wormwood or absinthe (*Artemisia absinthium* Linn.), nutmeg (*Myristica fragrans* Houtt.), etc., act directly on the central nervous system. The activity of the oils as nervous poisons varies greatly. In most cases the central nervous system is first stimulated and later depressed. In the case of absinthe, however, there is only a marked excitement resulting in convulsions.

The plants bearing essential oils are distributed widely in the vegetable kingdom while certain families, such as Labiatae, Rutaceae, Umbelliferae, Myrtaceae, Lauraceae, Piperaceae, and Coniferae are specially rich in such plants. Among the plants containing essential oils with toxic constituents may be mentioned species of the genera *Artemisia*, *Ruta*, *Mentha*, *Petroselinum*, *Chenopodium*, *Myristica*, *Eucalyptus*, *Gaultheria*, *Juniperus*, *Pinus*, *Eupatorium*, *Anemone*, *Ranunculus*, *Caltha*, *Prunus*, *Allium*, *Brassica* and other crucifers, *Piper*, *Ferula*, etc.

Resins

8. Resins form a group of heterogeneous collection of substances with complex and variable chemical composition and with some common physical properties. The main constituents of many resins are esters known as resin esters, complex acids known as resin acids, and substances of unknown constitution known as resenes. Some are found to contain phenolic substances with strongly irritant properties, while others contain bitter substances and have a strong purgative action. The chemistry of most of the resins is still obscure and recent investigations of some of these have resulted in the isolation of active constituents as distinct chemical substances, bringing them under other classes of compounds. For example, the purgative action of the resin from *Ecballium elaterium* A. Rich. has been traced to one of its components, β-elaterin, and the insecticidal properties of the resin from different species of *Derris* have been traced to the components, such as rotenone, deguelin, toxicarol, etc., which are pure chemical entities and can no longer be retained under the category of resins.

Resins having purgative properties are found to be present in *Podophyllum hexandrum* Royle (*P. emodi* Wall. *ex* Hook. *f.* & Thoms.), *Garcinia morella* Desr., *Citrullus colocynthis* Schrad., *Ecballium elaterium* A. Rich., *Convolvulus scammonia* Linn., *Ipomoea hederacea* (Linn.) Jacq., *Ipomoea purga* Hayne, etc. Resins having blistering or irritant properties are found in *Anacardium occidentale* Linn., *Holigarna*

arnottiana Hook. *f.*, *Rhus* sp., *Semecarpus anacardium* Linn. *f.*, *Euphorbia* sp., etc. And resins having insecticidal or toxic properties are known to be present in *Derris* sp., *Tephrosia* sp., *Calotropis* sp., *Cannabis sativa* Linn., etc.

Organic acids

9. Of the organic acids, the one significant from the poisoning point of view is oxalic acid, a protoplasmic poison, occurring in a large number of plants in the form of oxalates of calcium, sodium, and potassium. As a rule, oxalates occur in plants in too small quantities to produce poisoning. Several cases of poisoning among man and livestock have, however, been reported following the eating of the leaf blades of rhubarbs (*Rheum* sp.), sorrels (*Rumex* sp.), etc., where under certain conditions the oxalates are present in large amounts. They deprive the tissues of their calcium through precipitation. It should be remembered, however, that there is little danger from poisoning due to this source, if the plants containing them are consumed in ordinary amounts and the diet of the animal partaking them is rich in calcium.

Formic acid, an irritant substance, has also been found to occur in a few plants, *e.g.*, in the stinging nettles of the Urticaceae family. It has, however, lately been shown that the stinging effects of nettles are not due to formic acid, but to a more complex resin acid.

Tannins

10. The term tannins is applied to a group of phenol derivatives distinguished by giving a bluish or greenish colour with ferric salts. They are nonnitrogenous; some are glucosides. They have an astringent action and occur in many plants, especially in the leaves and bark, and in pathological formations (nut-galls). Poisoning of livestock, in some cases, has been ascribed to these, *e.g.*, in the case of acorns and leaves of oaks (*Quercus* sp.).

Photodynamic substances

11. Recent work has shown that the toxic effect of some plants is influenced by light, as they contain substances which when consumed by livestock make them sensitive to light. Such animals develop serious symptoms when they are exposed to sunlight after their feeds. Photosensitization takes place only in those animals who have no pigment in their skin and are white in colour; further it only appears if, after ingestion of sufficient quantities of the photodynamic substance, the animal is exposed to sunlight. If any one of these conditions is not fulfilled, symptoms may fail to develop. It should, however, be understood that the photodynamic substances do not always produce photosensitization. Among plants which produce photosensitization may be mentioned the buckwheat (*Fagopyrum esculentum* Moench and *F. tataricum* Gaertn.), St.-John's-wort (*Hypericum perforatum* Linn.), caltrop (*Tribulus terrestris* Linn.), and some species of *Trifolium*, *Medicago*, *Polygonum*, etc. Buckwheat grains and leaves produce

photosensitization in pigs and other animals, but not in man. The rest of these plants are not normally eaten by human beings.

Selenium and fluorine compounds

12. It has been shown during recent years that certain plants growing on seleniferous soils are able to absorb selenium compounds in sufficient quantities to make them poisonous. Thus, wheat (*Triticum aestivum* Linn.) which is ordinarily nonpoisonous to animals, may become harmful when grown on seleniferous soil, while in the case of those which are already poisonous, the toxicity may be increased. The "alkali disease" and the disease known as "blind staggers" in cattle and horses have been found to be due to feeding on plants which acquire toxic properties by the absorption of selenium. Fluorosis occurring in man and animals in certain parts of the Madras Presidency and the Punjab is due to the presence of excessive quantities of fluorine compounds in the soil which are taken up through water (*3*, *4*), or by feeding on plants grown in this area, or by both. These toxic substances are returned to the soil on the death and decomposition of the plants which absorb them and the animals who die from their effects; a vicious circle is thus maintained and the baneful effects are perpetuated.

Other toxic compounds

13. There are various other chemical compounds which cannot yet be strictly included in any of the classes of compounds described above. A toxic substance, known as andromedotoxin, is found in *Pieris ovalifolia* D. Don, several species of *Rhododendron*, and other genera belonging to the Ericaceae family; an irritant toxic substance plumbagin, a napthaquinone derivative, is present in different species of *Plumbago*; primin, a substance which causes dermatitis, is present in *Primula obconica* Hance; oenanthotoxin, a toxic substance, is found in *Oenanthe crocata* Linn.; grayanotoxin, a substance with larvicidal action, is present in *Leucothoe*; and finally, various substances, such as rotenone, tephrosin, deguelin, toxicarol, etc., which act as strong insecticides, are found in different species of *Derris*, *Tephrosia*, *Mundulea*, and *Millettia*, all belonging to the Leguminosae family. The chemical nature of these constituents is being gradually cleared up, and it is hoped that in time it will be possible to place them under their proper classes.

VI.—ACTION OF POISONS

A poison acts by modifying the normal functional activity of the cells upon which it acts. The effect on the cells may be marked by stimulation or depression of their function which may lead to complete destruction or death. The changes produced are quantitative.

Augmentation or overstimulation leads to gradual exhaustion which is manifested by a decrease in the functional activity, eventually ending in a complete stoppage of action or paralysis. From this stage there may or may not be recovery. Excessive stimulation may thus lead to actual death and disintegration of the body tissues. As regards the depression of normal functional activity, it is well known that some poisons produce a marked slowing of the usual cellular activity, leading to complete stoppage or paralysis from which there may or may not be recovery.

The action of poisons may be either: (*a*) local, (*b*) general, or (*c*) remote, or may be a combination of all three.

Local and general actions

Local action of a poison occurs without absorption and is usually induced at the site of application, before it gains entrance into the circulation; the *general* or *systemic action* is due to its elective affinity for certain organs to which it is carried by the circulation. Local effects are induced wherever the poison can be applied—to the skin, the alimentary and respiratory tracts, and other mucous membranes. They may also occur in the subcutaneous tissues when the poison is injected hypodermically. Many plants taken by mouth have an irritant action on the gastro-intestinal mucosa. This may be so violent in some cases that the mucous membrane is destroyed, with the result that the mechanism of absorption is altered to a great extent, and toxic substances ordinarily present in the alimentary tract, but not absorbed by the intact mucosa, gain entrance into the system and exert their harmful effects. In this way the irritant poisons, otherwise nonfatal, may cause death of the organism in an indirect manner.

Remote action

Poisons change directly only those organs and tissues with which they come into contact. But the alteration of one part of the organism very often entails that of another to which the drug may not have access or for which it has no special affinity. This is brought about by impulses which are transmitted through the nerves or changes which are induced in the circulation and nutrition of distant organs. These secondary changes, which are not due to the direct action of the poison on the organs concerned, are known as *remote* or *indirect effects*.

Selective action

Most poisons have an affinity for certain tissues. Thus some affect the heart only, others the central nervous system, and others again the terminations of the motor nerves in different organs. Poisons affecting the blood may cause haemolysis or may attach themselves to the red blood corpuscles and replace the oxygen in other ways. In all these cases death is due to asphyxia. Different parts of the central nervous system are affected by different poisons; thus atropine stimulates the brain while morphine chiefly causes a depression; the

spinal cord is affected by strychnine whereas the nerve endings are acted upon by pilocarpine or physostigmine. The respiratory, the alimentary and the genito-urinary systems may also be affected by specific poisons. Some poisons may, however, produce their effects after a comparatively longer latent period.

1.—Conditions affecting the action of poisons

The effect of poison on the system is often very materially modified by a number of circumstances, and these may be conveniently divided into two groups: (*A*) Those relating to the poison itself and its administration, and (*B*) those relating to the individual.

Physical properties of poisons

(*A*) In order that a substance may act as a poison it must be capable of entering the blood or in other words it must be soluble. It is, therefore, evident that no substance can be a poison if it is entirely insoluble. Poisons generally produce their effects more slowly and less energetically in a solid form than when they are in solution; in the form of a pill or tablet, their action is likely to be more retarded.

Poisons when administered on a stomach full of solid food are generally more slowly dissolved and less rapidly absorbed, and as a consequence produce their effects somewhat more slowly and frequently less severely than when given on an empty stomach. The importance of this fact in toxicology is often great and it explains at times many seeming anomalies in the action of poisons.

Route of administration

As a rule poisons produce practically the same effect by whatever route they enter the circulation, the only difference being the variability in the rate of absorption. In a few cases, however, the avenue of entrance materially modifies the action. Thus curare is toxic only to a very slight degree when administered by mouth, although intensely poisonous when given by injection. The same is the case with saponins.

It is by no means a matter of indifference by what channel a poison is introduced into the body. The route of entry affects the action of the poison, and is dependent on the varying degrees of vascularity and absorptivity of different tissues. This influences the rate of entrance of the poison into the blood stream and hence the degree of the action produced.

The action of a poison is eventually dependent upon its concentration in the cell on which it acts. The concentration depends primarily upon the dose taken, but is modified by the rate of absorption and the rate at which the body frees itself from the poison by excreting it or changing it into an inert form. Small divided doses may not, therefore, produce the same symptoms as administration of the same amount undivided.

Condition of the individual

(*B*) The chief conditions relating to the individual that modify the effects of poisons are :—

Excitability of tissues

The excitability of the tissues is influenced by a large number of conditions which may be grouped as physiological and pathological.

Physiological processes

Physiological processes depend on such factors as the rate of excretion, the condition of the subject (menstruation, pregnancy, lactation), nutrition, age, sex, habit, and idiosyncrasy. Temporary conditions also influence the activity of poisons, thus, after a meal a poison is absorbed more slowly and any local irritant action is also less marked because of its dilution.

Pathological condition

Pathological conditions may modify the action of poisons to a considerable extent. Thus, in cases of certain affections of the stomach, little or no absorption may take place. Vomiting and diarrhoea, of course, tend to lessen the action of a poison by removing it rapidly from the alimentary canal.

Susceptibility

Susceptibility varies with different persons. Two individuals of the same age, sex, race, and weight will respond differently to equal doses of the same poison. This is but an example of the natural variation in the response of living matter to a change in environment ; some are over-responsive, others respond to a comparatively less extent to the same stimulus. Then there is the specific variation, which may be extreme in degree, but limited to certain poisons and drugs. The response in these cases is an inherent one confined to a few poisons only, and, according to the underlying cause, it may be divided into two groups :—

Idiosyncrasy

(*a*) Idiosyncrasy is an unusual specific response which is shown only by isolated individuals and is usually an exaggeration of some side-effects. Animals are notorious for the exhibition of idiosyncrasy. Qualitative differences are seen particularly in the action of *Cannabis sativa* Linn. on dogs. In addition, the susceptibility of animals to a number of poisons varies considerably with the season.

Tolerance

(*b*) Tolerance is the lack of response to a poison, which may be partial or complete. It may be natural or acquired. Natural tolerance is that possessed by certain races and animals rather than by individuals. It means that the freedom from the action of a poison is inborn or indigenous. The mechanism of the production of tolerance is not clearly understood. Rats are very tolerant to digitalis, birds to opium, the rodents generally to emetics, and the herbivora to atropine. The resistance of hedgehog to poisons, such as morphine, nicotine, atropine, cyanides, and arsenites, but not to strychnine cannot be explained. Natural tolerance may be due to the inherent power of the tissues to neutralize poisons or to a greater power of excretion than absorption, *e.g.*, curare.

Acquired tolerance

Acquired tolerance is due to a process of habituation, that is, by repeated administration of the poison in increasing doses. The organism does not start with an inital tolerance, but gradually builds it up; its tissues learning how to deal with the poison by gradual experience. It, therefore, differs from the natural tolerance in being a matter of cell education. A common example of acquired tolerance is met with in opium addicts who may take as much as 200 grains or more of this drug in a day.

Tolerance differs from immunity in that antitoxins are said to be formed in the latter. Antitoxin formation, however, is an instance of acquired tolerance. It was believed to be confined to the proteins, but it has also been shown in case of certain glucosides, toadstools, and snake venom. It has not been known among alkaloids.

2.—Cumulative action

It has already been indicated that some poisons are excreted more rapidly than they are absorbed and with these it is difficult to obtain sufficient concentration in the blood at one time to produce a specific effect. The example of curare by mouth and injection has already been cited. Cumulation is the opposite effect to this. Here small doses of certain drugs (digitalis, emetine, etc.) constantly repeated may produce quite suddenly symptoms of such a nature as to suggest either the absorption of a large dose or a deficiency in the excretion. After each dose all the drug administered is not excreted or destroyed, but a part of it remains in the system and eventually attains the concentration at which symptoms of poisoning are manifested. It has been suggested that cumulative action may be a " summation " effect and not necessarily due to accumulation of the drug in the tissues. It is stated that the susceptibility of an animal to strychnine increases with its continued administration, but strychnine is very slowly excreted and so the increased susceptibility is more likely to be due to an accumulation of the drug in the tissues than to a summation of effects.

VII.—SYMPTOMS AND DIAGNOSIS OF POISONING WITH PLANTS

The detection of poisoning in the living subject is a matter of great importance, as otherwise the symptoms produced may be mistaken for those resulting from disease, and in consequence of the nonemployment of the antidotes and the treatment necessary to counteract the effects of poison, death may result. Moreover, in cases in which a poison proves

fatal, the symptoms produced by it may provide important evidence as to its nature or identity.

Unfortunately, however, the diagnosis of poisoning is usually exceedingly difficult and frequently impossible in the living subject. This is due to the fact that with the exception in most cases of corrosive poisons and of strychnine, the symptoms produced by poisons are not clearly characteristic, and cannot by themselves be distinguished from symptoms of disease with absolute certainty, even by the most experienced of observers.

Simulation of disease

The diseases simulating poisoning are many. Those resembling irritant poisoning are chiefly cholera, acute indigestion, ulceration of the stomach or duodenum, gastritis, gastro-enteritis, peritonitis, appendicitis, and hepatic and possibly renal colic. Those whose symptoms resemble poisoning by narcotics are cerebral haemorrhage, thrombosis, epilepsy, convulsions in certain organic brain diseases, tetanus, inflammation of the meninges, uraemia, etc.

As an aid to diagnosis, the symptoms of each poison should be studied separately, but at the same time it must be remembered that unusual and unexpected symptoms may follow the administration of almost any poison. A careful consideration of the symptoms and of certain concomitant circumstances or conditions will often enable one to arrive at a conclusion of presumable accuracy.

Clinical investigation

The following are the recognized and classical rules which are helpful in the investigation of suspected cases of poisoning :—

Careful attention should be given to every detail of the history of events preceding the onset of poisoning or suspected poisoning, and these should be carefully and critically examined. In the case of animals, information regarding the feeding or grazing just before the development of the symptoms is always helpful. In this connection it should be remembered that in certain cases of plant poisoning, *e.g.*,in *Pachystigma pygmaea* (Schlecht.) Robyns, symptoms might appear after a latent period of several months (*5*).

Symptomatology

In most cases of poisoning, the symptoms are, as a rule, sudden in their onset and generally occur when the subject is in apparent good health. The symptoms frequently appear either after a meal or after taking some food, and this generally constitutes one of the most important indications of poisoning. The recognition of a case of poisoning can only be made certain by the detection of poisons in some of the food that has been eaten or in the contents of the stomach.

Diagnosis

The diagnosis of poisoning in most cases has to rest upon the characteristic course of the clinical symptoms coupled with the history of

exposure to the poisons in question, and confirmed by morbid anatomical and histological changes found *post mortem*.

Post-mortem evidence

The evidence afforded by a *post-mortem* examination in a case of suspected poisoning is important, but is rarely conclusive. Many cases are on record where death has occurred from plant poisoning and no *post-mortem* evidence has been of any value. Even the appearances that are the most characteristic and which are usually looked for with the greatest confidence may be entirely wanting.

No *post-mortem* investigation can be considered complete without a careful microscopic examination of the heart, kidneys, lungs, liver, and, if possible, of the brain and spinal cord.

Chemical analysis

Since it is only in exceptional instances that a case can positively be established as one of poisoning, either by the symptoms or the *post-mortem* appearances or even by both, a final decision in regard to the matter can generally be reached solely by chemical analysis. While it is true that in most cases the stomach is the most desirable part of the body for examination, other organs should also be submitted for analysis, and of these the most important, as a rule, are the liver, the kidneys, and bowels. The brain, spinal cord, heart, blood, and urine are frequently of service ; in fact there is scarcely any part of the body that may not be tested chemically with profit.

VIII.—PROGNOSIS OF POISONING

In most cases of plant poisoning it is very difficult to predict with certainty the results with regard to the effect of poison on the system, that is, whether the poisoning will end in the death of the organism or subsequent recovery. There are many factors that determine the prognosis in such cases : (*a*) Those concerned with the plant, its stage of growth, seasonal variation and climatic condition, parts of the plant, etc. All these determine the toxicity of the plant. (*b*) Those concerned with the animal, *e.g.*, age, sex, weight and development, susceptibility, tolerance and immunity to plant poisons, etc. In the case of plants which contain more than one poisonous principle, the prognosis is even more difficult to express. The animal in such cases may recover from the immediate effect of one toxic factor acting more rapidly—only to succumb to the effects of the other which exerts its action only after a latent period. An example of this is *Adenia digitata* Engl., the tuber of which contains prussic acid and the toxalbumin modeccin.

To a great extent, the treatment modifies the prognosis, and, as a rule, the sooner the treatment is started the more favourable is the prognosis.

IX.—TREATMENT OF POISONING

Each individual case of poisoning must be dealt with on its own merits, but there are certain general principles which are universally applicable. On account of the rapid course of poisoning prompt measures are of vital importance. The physicians and the veterinarians must be familiar with the different antidotes and with the general rules of treatment.

The general principles of treatment in all cases of poisoning consist in (*a*) the removal of the poisons or rendering them inert so that further absorption is prevented ; (*b*) the elimination from the system of the poisons already absorbed ; and (*c*) the treatment for the symptoms of poisoning.

1.—Removal of the poison

Attempts must be made first of all to remove the poison and this depends upon the site to which the poison was applied.

Local measures

When the poison is applied to the skin or accessible mucous membrane, the surface should be thoroughly washed with water with which some chemical antidote has advantageously been mixed. If the poison is sparingly soluble in water, alcohol may be used. When the poison has been administered by injection or by application to wounds, further absorption may be prevented by applying a firm ligature proximally to the site of the wound. Suction, cautery, or excision may also be tried.

Systemic measures

If the poison is taken by mouth, the most effective method to prevent or retard further absorption is to withhold water by mouth. The removal of poison from the stomach may be accomplished either by inducing vomiting or by the use of a stomach tube. If, as is often the case, vomiting is already present, it is usually sufficient simply to encourage it by the administration of copious draughts of tepid water, to which some common salt is added.

Emetics

Emetics may be tried if the vomiting is not copious. The most useful ones are a teaspoonful of common salt in a tumbler of water, a dessertspoonful of ground mustard, 15 grains of zinc sulphate or 5 grains of copper sulphate in tepid water, but these should be used with caution. Central emetics such as apomorphine bihydrochloride may be tried, but apomorphine in emetic doses has a dangerous cardiac depressant action and its use is often inadvisable.

Gastric lavage

The stomach tube is usually to be preferred to emetics because it produces less prostration and is generally more effective for complete removal of the poison. Further, by this means the stomach can be washed out and the last traces of poisons removed by repeating

the process if necessary. The tube should be introduced with care to avoid injury to the parts with which it comes in contact. As a rule a pint of tepid water should at once be introduced into the stomach through the tube and removed by suction with a pump, and the operation repeated a number of times until it is evident that the contents of the stomach have been completely washed out. Antidotes may generally with advantage be placed in the water, as a portion almost always remains in the stomach and delays the action of the poison. If the contents of the stomach consist of large pieces of food, and it is not possible to empty the organ by a tube, preliminary evacuation with an emetic may first be tried. After this, the tube may be used to wash out the stomach more thoroughly. Gastric lavage may be repeated after two or three hours to remove any regurgitant fluids and the poisons that may be excreted into the stomach. The absorption of the poisons still present in the gastro-intestinal canal may be retarded or prevented by neutralizing them with suitable antidotes.

2.—Antidotes

Antidotes are of two kinds: (*a*) Those that act mechanically, and (*b*) those that act chemically.

Physical antidotes

(*a*) Antidotes that act mechanically are either those that envelop the poison in some insoluble material, or those that coat the mucous membrane of the stomach in a similar manner; in either case the result is a greatly reduced rate of absorption of the poison. The most important of the substances belonging to this group are fats and oils, milk, white of egg, and charcoal in a fine state of subdivision. Activated charcoal and animal charcoal (bone black) are effective adsorbents of many alkaloids. Fats and oils are of very wide utility, both on account of materially retarding the absorption of the poison and also by protecting the mucous membrane of the stomach from corrosive or irritant action. In cases of poisoning, however, by a few substances, such as phosphorus, camphor, aspidium, and cantharides, fats are entirely inadmissible, as they dissolve the poison and render it much more active.

Chemical antidotes

(*b*) The majority of antidotes that act chemically do so by reacting with the poison, producing insoluble or sparingly soluble compounds. Some, however, act by changing the chemical character of the poison without the production necessarily of an insoluble body, as is the case when acids are used to neutralize caustic alkalis, or when potassium permanganate is administered as an antidote to morphine. When using chemical antidotes it should always be borne in mind that the compounds produced are often only relatively harmless, and that if

allowed to remain in the stomach for some time serious results may be produced. In all cases, therefore, it is advisable, after the administration of an antidote, to empty the stomach, repeating the operation a number of times.

It has to be admitted that it is sometimes extremely difficult to determine when all the poison has been removed from the stomach, and when antidotes may be safely discontinued. In poisoning by opium and its derivatives, it is especially important to continue the use of antidotes, as it is well known that, however these poisons are administered, their poisonous principles are eliminated to a considerable degree by the mucous membrane of the stomach. Washing out that organ, therefore, and administration of antidotes are serviceable at almost all stages.

3.—Elimination of poisons already absorbed

Purgatives

Elimination of poisons already absorbed can be attempted by increasing the excretions, but is usually not very successful. The administration of purgatives stimulates the secretion of the glands of the gastro-intestinal mucosa, which excrete many poisons, and in addition such drugs by hurrying along the contents of the gut prevent to a certain extent the reabsorption of the poisons which have been excreted in the intestinal tract. The principal remaining channels of excretion are the urine and sweat, of which the former is the more important.

Diuretics and diaphoretics

Stimulating the renal secretion by means of diuretics, *e.g.*, water, especially weak tea and carbonated drinks, theobromine, potassium acetate, etc., may help in some cases, but the effect is very limited even for such substances as strychnine. Irritant diuretics should always be avoided for obvious reasons. Diaphoretics in the form of hot drinks, heat, and pilocarpine may also facilitate the excretion of poisons. Elimination of poisons through these channels is, however, never very large in actual practice.

4.—Symptomatic treatment

Physiological antidotes

The symptoms produced by poisons can be lessened or removed by the use of drugs with an opposite action. These physiological antidotes may not actually abolish the action of the poison ; they may only mask its symptoms. Probably the best example of physiological antagonism is that shown by atropine and physostigmine. In most cases the antagonism is usually limited to only one or two of the effects produced ; their action in other respects may not infrequently be synergistic. Thus atropine increases the reflex function of the central nervous system, while morphine lessens it, and consequently the former in small doses may be used with advantage as a partial physiological antidote in the treatment of opium poisoning. Among other antidotes may be

mentioned atropine to pilocarpine, strychnine to nicotine, digitalis to aconite, chloral to strychnine, caffeine to morphine, and each of them has been used in the treatment of poisoning by the other.

General measures

General measures are directed in the order of their importance towards supporting the respiration, heart and vasomotor tone, and towards lessening pain, convulsion and coma.

Respiration

Respiration is usually the first function to fail, and this accelerates the other actions of the poison. As soon as the respiration shows signs of weakening, steps should be taken to support this function. The measures consist in direct or reflex stimulation of the respiratory centre, in artificial respiration, and in the administration of oxygen.

Reflex stimulation of the respiratory centre is the quickest method, but cannot be sustained as long as direct stimulation. The means adopted for the purpose are inhalation of ammonia or smelling salts, administration of aromatic spirits of ammonia, alternate application of heat and cold, friction with alcohol, hypodermic injection of camphorated oil, whisky or ether, mustard plaster, faradization, etc.

Carbon dioxide acts as a physiological stimulant to the respiratory centre. Administration of 5 per cent carbon dioxide with oxygen by a special mouth-piece ensures free lung ventilation and stimulation of the failing respiratory centre.

Direct stimulation of the respiratory centre is effected with rather limited success by strong hot coffee, strychnine, or atropine.

Artificial respiration should be applied whenever the above measures are ineffectual. It should, however, be remembered that very prolonged and violent artificial respiration may injure the lungs. If the heart is strong, artificial respiration should be given at intervals.

Circulation

It is sometimes possible to improve a failing heart by reflex stimulation or by the intravenous injection of normal saline solution. Lowering the head and bandaging the extremities also adds to the blood supply of the brain and heart.

If the heart has been arrested through asphyxia, rather than through a direct cardiac action of the poisons, and if it has not stopped longer than a few minutes, it may sometimes be resuscitated by a cardiac massage, combined with epinephrine by the intravenous or more effectively by the intracardiac route.

Artificial heat must be employed where surface of the body generally or the extremities are cold. General stimulants, such as cardiazol, alcohol in small doses, ammonia by inhalation, aromatic spirit of ammonia

by mouth, and strychnine preferably by hypodermic injection, should be used as indications arise.

Feeding

Feeding in cases of prolonged coma is important. Glucose, peptonized milk, coffee, etc., may be given by a stomach tube. Normal saline with glucose may be given per rectum by the continuous-drip method or by injection.

Restoration of functions of damaged organs

In almost all cases of poisoning that are not immediately fatal, the brunt often falls on the liver and the kidneys, and suppression of functions of these organs results. After immediate measures for elimination of the poisons have been adopted, it is necessary to carry on careful and energetic treatment to restore the functions of the damaged organs.

Liver

It is well known that the liver cells are more resistant to the effects of poisons if they are stocked with glycogen. It is, therefore, advisable to give 2 to 3 ounces or more of glucose by mouth every day. This has a prophylactic value against the occurrence of toxic symptoms. The treatment of liver damage should be started immediately the earliest manifestations of such disorders become evident. These symptoms are nausea, vomiting, furred tongue, headache, muscular twitchings, mental irritability, delirium, and stupor. Icterus index is found to be raised above normal. The treatment consists in a liberal administration of glucose by mouth, per rectum, subcutaneously or intravenously. Alkalis, such as potassium citrate, sodium citrate or sodium bicarbonate may be given in large doses every two hours. Calcium gluconate, parathormone, and liver extracts are the other therapeutic preparations used. Diet should be such that it throws least strain on the liver metabolism. When pronounced symptoms, such as coma or convulsions, are present, repeated lumbar punctures in addition to the line of treatment indicated above may prove useful.

Kidneys

In a number of cases the kidneys are damaged severely, and there is failure of their function with suppression of urine and ultimately the onset of uraemia. In these cases the treatment consists in the giving of a diet which will not throw any strain on the kidneys, and administration of saline, glucose, and alkali. Skin action is promoted by radiant heat. Only diuretics of the xanthine group are used ; mercurials should be avoided as they may irritate.

5.—Conclusion

It will thus be seen that the treatment of poisoning resolves itself into the adoption of: (*a*) measures for counteracting the immediate effects of the poison and removal from the site where it is applied, and (*b*) of measures for restoring the normal physiological functions of the organs damaged by the poison.

X.—FACTORS DETERMINING THE TOXICITY OF PLANTS

1.—Factors relating to plants

It is a curious fact that many plants are quite harmless as articles of human and animal dietary under certain conditions, whilst under other circumstances they may prove to be poisonous. It is also well known that individual plants of the same species growing in different localities vary to a considerable extent in the content of their active principles. Most interesting of all, however, is the fact that plants belonging to the same species and growing near each other under identical conditions show remarkable differences in the contents of their active principles. This variability in the amount of poisonous substances present in plants is dependent upon several factors. The way in which these factors modify the toxicity of plants is not very clearly understood, but the following points may be considered to play an important part:—

Correct identification

Proper identification of the plant is extremely important and if there are several varieties and forms of the same species, each one of these should be carefully examined in order to determine which contains the highest amount of active principles. Sometimes light can only be thrown on this aspect of the problem by extensive and intensive work in the field. For example, there are two forms of *Artemisia maritima* Linn. in the Kurrum Agency. In the early stages of growth, one has deep-reddish stems and the other greyish. The stems of both turn brownish at the time of maturity, but it is only the form with deep-reddish stems in the early stages of growth (*A. maritima* Linn., forma *rubricaule* Badhwar), that contains santonin. There is absolutely no other botanical difference between them. The differentiation of these forms defied even skilled botanists for a long time and considerably hampered the progress of the santonin industry in India till Badhwar (*6*) brought this fact to light. This is a very remarkable example of the fact that even the slightest differences in a plant may reveal such unexpected differences in reference to the content of active principles.

Stage of growth

The stage of growth of a plant or of its particular organ is perhaps the most impor ant factor in determining its toxicity. Some species of *Sorghum* and other grasses when young and wilted or stunted, contain fatal quantities of hydrocyanic acid. The green berries of *Solanum nigrum* Linn. are harmful, while the ripe ones are edible. The flower-heads of pyrethrum (*Chrysanthemum cinerariifolium* Vis.) contain a larger amount of pyrethrins at the time of or just before fertilization than later on when the seed is being formed or matured. The unopened flower-heads of *Artemisia maritima* Linn. yield greater amounts of

santonin than the opened ones; likewise there is a difference of santonin content in the young and old leaves of artemisia despite the fact that they may be collected at the same time and hence at the same stage of maturity of the plant. Numerous other examples could be cited to show that the stage of maturity of the plant or its different parts is a very important factor in the determination of the development of its active principles. No hard and fast rules can be laid down with regard to the time when the active principles attain their maximum. Detailed investigation of each plant concerned is the best means of knowing its periods of maximum and minimum toxicity with certainty, but the following general rules given by Chopra and Badhwar (7) regarding the time of development of the highest amounts of active principles in plants may be mentioned :—

1. Roots, rhizomes, and bark—late in autumn or early spring.
2. Leaves—when photosynthetic processes are most active, which is usually the time of development of flowers and before maturing of fruits and seeds.
3. Flowers—prior to or just about the time of pollination.
4. Fruits—near the ripening period, *i.e.*, fully grown but unripe.
5. Seeds—when fully mature.

Condition of plant

It has been already mentioned under "*Conception of a poisonous plant*" how several plants, such as potato and grasses, which normally provide valuable food to man and animals may acquire toxic properties during sprouting, or when wilted or stunted, while others, such as the yams and certain aroids, which are poisonous when fresh, lose their toxicity on drying or boiling. Some plants when dried and stored rapidly lose their toxicity, while others retain their active principles for prolonged periods. Amongst plants which lose their toxicity on drying and storage may be mentioned those which have gaseous (hydrocyanic acid) or volatile active principles. The process of oxidation, dehydration, or hydrolysis which may set in during storage may also destroy the active principles of several plants. Investigation of decomposed plants or those attacked by fungi, for the presence of their normal chemical constituents, is not advisable, since both the decomposed matter and the fungi may of themselves liberate toxic substances.

Soil and cultivation

The structure and composition of the soil, the amount of moisture present, and its temperature influence the metabolic activity of a plant. The different kinds of soil may, therefore, modify the production of poisons in the plants and hence their toxicity, at least in some cases. In some plants, cultivation may result in a decrease in the toxicity or even complete disappearance of the active principles, *e.g.*, in gourds (Cucurbi-

taceae) and Lima or Duffin bean (*Phaseolus lunatus* Linn.). In other cases, such as *Cinchona* and oleander (*Nerium*), cultivation appears to have no effect and the active constituents do not deteriorate; in the case of *Cinchona* they may actually be enhanced.

Climatic conditions

Climatic conditions, such as temperature, humidity, and the nature and intensity of light also play a part in the production of poisons in plants, on account of their influence on the latter's metabolic activity. Chopra and collaborators (*8*) have shown that species of *Ephedra* contain larger amounts of active principles in areas with low rainfall than in localities with high rainfall. They have also found that the alkaloidal content of these plants is less in rainy than in dry years. The variation of active principles of plants during different hours of the day, as has been noticed in the case of many plants by several authors, is due to the varying conditions of temperature, humidity, and light during this period. Furthermore, the seasonal variation of the active principles of plants, so much stressed by various authors, does not appear to us on careful analysis to be anything more than the direct result of the stage of growth of the plants coupled with prevailing climatic conditions.

Toxic parts of plants

It is well known that different parts of a plant vary considerably in the amount of toxic principles contained in them. Thus the toxicity of the roots, stems, leaves, flowers, fruits, and seeds varies considerably in almost every plant, even at the same stage of its growth. One or more parts of a plant may be poisonous while the remaining ones may be quite harmless and may even form a part of human or animal diet. Several examples of this could be cited but it is enough to point out the common instances of peach, plum, and some forms of apricots, the kernels of which may contain dangerous quantities of hydrocyanic acid but the outer portions of their fruits are quite safe and edible.

2.—Factors relating to animals

Above are some of the factors concerned with the plant itself, which affect its toxicity. The other factors are with regard to the animal, and have already been dealt with under the "*Action of poisons*". The most important among these are the rate at which such plants are ingested and the time that the body takes to eliminate or to destroy the poisonous principles.

XI.—ECONOMIC AND TOXICOLOGICAL ASPECTS

The importance of the study of poisonous plants, from their economic and toxicological aspects in relation to man and animals, cannot be overrated. It should be borne in mind that they are at once our friends

and our enemies. Most of the plants which are harmful to man and livestock in large quantities, produce remarkably beneficial effects in small and regulated doses. From the economic point of view, therefore, this group of plants is of very great importance inasmuch as it provides us with medicinal agents of every description, not only sufficient for our own use but also for purposes of export. The destruction of insects, those great enemies of social and economic progress, by means of vegetable resources is becoming increasingly important in the economy of the civilized world. The poisonous plants have also been used by man for fighting his enemies and for procuring his food by killing animals by their means. To catch fish as an article of diet, man has from time immemorial utilized poisonous plants. Of great use as the poisonous plants are to mankind, their presence in our midst is a serious menace to man and livestock, producing death or illness through accident, ignorance or intention. Chopra and Badhwar (*9*) have recently directed attention to the various aspects of the poisonous plants of India. From the economic and toxicological points of view they have divided the poisonous plants into two main groups, *viz.*, 1. plants poisonous to man and livestock, and 2. plants poisonous to insects and fishes.

1.—Plants poisonous to man and livestock

Poisoning of man

Stock poisoning

On the whole, our knowledge is fairly well advanced so far as the relationship of poisonous plants to mankind is concerned, but even here considerable gaps exist. In civilized man poisoning by accident, ignorance or intention is met with even at the present time. It is, however, in connection with poisoning of livestock that our knowledge in this country is very meagre, as compared with other countries. In India there are hundreds of plants that are intimately connected with the food supply of roughly 220 millions of the bovine population, out of a total of about 730 millions in the whole world, and of about 100 millions of other livestock, including sheep, goats, etc. Excluding the concentrates that are in use, the fodder supply for this livestock amounts to at least 35 million maunds daily (maund=82 lbs). Even in its present unsatisfactory condition, the cattle industry contributes roughly about 10,000 million rupees to the annual agricultural income of 20,000 million rupees of this vast country. Unfortunately no figures are available of the loss suffered through poisoning with plants in India, but we believe that it must be enormous. It may be interesting here to give the example of two States, Montana and Colorado in the United States of America, which give some idea of the possible damage. In that area it has been computed that the loss inflicted to the livestock industry by plant poisoning is in the neighbourhood of 200 million dollars annually. This is a very large

figure considering that the size and extent of these States as compared with India is less than one sixth, and also in view of the fact that the knowledge of the poisonous plants of the areas is well advanced and active preventive measures are in vogue.

Though the number of plants which have markedly poisonous properties is small as compared with the total species included in the Indian flora, there are many which are of common occurrence and which no doubt produce serious loss by death or illness they set up among sheep, cattle, and other domestic animals. The toxic effects produced may be accompanied by reduction in the yield of milk, or the milk may become unpalatable or actually poisonous and, therefore, unfit for consumption.

CONDITIONS UNDER WHICH POISONING IS PRODUCED

By contact

Poisoning may be produced through contact with the skin as in the case of some species belonging to the genera *Rhus, Holigarna, Urtica,* etc., resulting in minor or temporary irritation of the skin or painful irritation and inflammation with vesicles or blisters, depending on the severity of the contact and the susceptibility of the individual.

The following is the list of plants found in India, which have caused dermatitis. The part or parts of the plant that is responsible for this condition is indicated for each species. A number of them produce dermatitis only occasionally or in individuals who are especially susceptible. Others are more troublesome and cause dermatitis in many but not all individuals who may come in contact with them. The more troublesome plants in the following list have been marked with an asterisk :—

PLANTS PRODUCING DERMATITIS

**Abroma augusta* Linn. *f.*	Irritant hairs.
Ailanthus altissima (Mill.) Swingle (*A. glandulosa* Desf.)	Leaves, flowers.
**Anacardium occidentale* Linn.	Juice from pericarp and trunk.
Anagallis arvensis Linn.	Leaves.
Anthemis cotula Linn.	Leaves, flowers.
Apium graveolens Linn. (wild form)	Leaves.
**Arisaema speciousm* (Wall.) Mart.	Juice, especially from tubers.
Arisaema tortuosum (Wall.) Schott	Juice, especially from tubers.
Asparagus officinalis Linn.	Young stems.
Calotropis gigantea (Linn.) Dryand.	Milky juice.
Calotropis procera (Linn.) Dryand.	Milky juice.
Cannabis sativa Linn.	Leaves, flowers.
Cissus setosa Roxb. (*Vitis setosa* Wall.)	Juice.
Datura stramonium Linn.	Leaves, flowers, fruits.
Daucus carota Linn.	Leaves.

Delphinium ajacis Linn.	Leaves, seeds.
Dictamnus albus Linn.	Leaves, capsules.
Erigeron canadensis Linn.	Leaves.
Euphorbia acaulis Roxb. (*E. fusiformis* Buch.-Ham.)	Milky juice.
**Euphorbia antiquorum* Linn.	Milky juice.
Euphorbia cattimandoo W. Elliot (*E. trigona* Fl. Brit. Ind., in part)	Milky juice.
Euphorbia helioscopia Linn.	Milky juice.
Euphorbia neriifolia Linn.	Milky juice.
Euphorbia nivulia Buch.-Ham.	Milky juice.
Euphorbia peplus Linn.	Milky juice.
Euphorbia rothiana Spreng.	Milky juice.
Euphorbia royleana Boiss.	Milky juice.
Euphorbia thomsoniana Boiss.	Milky juice.
Euphorbia tirucalli Linn.	Milky juice.
Euphorbia trigona Haw. (*E. trigona* Fl. Brit. Ind., in part)	Milky juice.
**Excoecaria agallocha* Linn.	Milky juice.
Fagopyrum esculentum Moench	Leaves.
**Fleurya interrupta* Gaudich.	Stinging hairs on plant.
Ginkgo biloba Linn.	Seeds.
**Girardinia heterophylla* Decne. (with varieties mentioned in Fl. Brit. Ind., which are now treated as distinct species)	Stinging hairs on plant.
Hedera helix Linn.	Leaves.
Hippomane mancinella Linn.	Juice.
**Holigarna arnottiana* Hook. *f.*	Juice.
Holigarna grahamii (Wight) Hook. *f.*	Juice.
Holigarna longifolia Buch.-Ham. *ex* Roxb. ..	Juice.
Humulus lupulus Linn.	Leaves.
Hypericum perforatum Linn.	Leaves.
**Laportea crenulata* Gaudich.	Stinging hairs on plant.
**Laportea terminalis* Wight	Stinging hairs on plant.
Lasiosiphon eriocephalus Decne.	Bark.
Leonurus cardiaca Linn.	Leaves.
Lobelia excelsa Lesch.	Milky juice.
Lobelia nicotianifolia Heyne	Milky juice.
**Mucuna atropurpurea* DC.	Irritating bristles on pods.
**Mucuna gigantea* DC.	Irritating bristles on pods.
**Mucuna hirsuta* Wight & Arn.	Irritating bristles on pods.
**Mucuna monosperma* DC.	Irritating bristles on pods.
**Mucuna nigricans* (Lour.) Steud. (*M. imbricata* DC.)	Irritating bristles on pods.
**Mucuna prurita* Hook. (*M. pruriens* Fl. Brit. Ind., *non* DC.)	Irritating bristles on pods.
Nerium oleander Linn.	Leaves.
Podophyllum hexandrum Royle (*P. emodi* Wall. *ex* Hook. *f.* & Thoms.)	Rootstocks.
Polygonum hydropiper Linn.	Leaves.
Ranunculus sceleratus Linn.	Leaves.
**Rhus insignis* Hook. *f.*	Leaves, bark, fruit.
**Rhus punjabensis* J. L. Stew. *ex* Brand. ..	Leaves, bark, fruit.
**Rhus succedanea* Linn.	Leaves, bark, fruit.

**Rhus wallichii* Hook. *f.*	Leaves, bark, fruit.
Rumex acetosa Linn.	Leaves.
Rumex acetosella Linn.	Leaves.
Ruta graveolens Linn.	Leaves.
Sapium insigne Trimen	Milky juice.
**Schima wallichii* Choisy	Bark.
**Semecarpus anacardium* Linn. *f.*	Juice from pericarp and bark.
**Semecarpus travancoricus* Bedd.	Juice.
**Tragia bicolor* Miq.	Stinging hairs on plant.
**Tragia involucrata* Linn. (with varieties in Fl. Brit. Ind., which are now treated as distinct species)	Stinging hairs on plant.
**Urtica dioica* Linn.	Stinging hairs on plant.
**Urtica hyperborea* Jacquem. *ex* Wedd. ..	Stinging hairs on plant.
**Urtica parviflora* Roxb.	Stinging hairs on plant.
**Urtica pilulifera* Linn.	Stinging hairs on plant.
Wallichia disticha T. Anders.	Leaves, berries.

Eating of poisonous plants

In the majority of cases, however, the toxic principles of plants gain entrance through the digestive tract, *i.e.*, poisoning is produced when the plants are eaten. Cases of poisoning in animals through eating of poisonous plants are of frequent occurrence in all parts of the world, and they are quite common in this country. This is due to the fact that in many parts of India good and palatable forage is often not easily available and poisonous plants may be ingested when animals are grazing on pastures where forage is very limited. They may also be included among the forage that is collected, often indiscriminately, and brought in by ignorant people who often have no knowledge of these plants. Poisoning of livestock is frequently met with in winter, or in early spring when " grass " is just coming up, or in the late summer when it is dried up, or in seasons of drought. The animals under such circumstances, when fodder is not abundant, are more prone to eat noxious plants which they would not do in times of plenty. Besides this, overgrazing is common in many parts of India and the number of animals grazed per unit of area is often in excess of the palatable fodder required to satisfy them. They are, therefore, more likely to eat unwholesome and harmful plants and this further increases the incidence of poisoning. Animals introduced into new areas are often unable to exercise their sense of discrimination among the new vegetation and fall easy victims. We have often come across such instances in the Himalayas where the shepherds and cowherds take their livestock in the summer from the plains to the hills for grazing. During early summer, partly owing to the scarcity of fodder and partly owing to the new herbage, there are serious losses among their animals. Likewise animals fed in the stable and those brought up under unnatural conditions lose their sense of discrimination. A biological fact of considerable importance in the distribution of poisonous plants is that they are not normally eaten by

animals. In places, where close grazing has been allowed, they are usually left untouched by livestock while the wholesome forage is eaten up. The poisonous plants, therefore, meet with less competition from the wholesome plants and increase more rapidly through the agency of animals themselves. In course of time they form a much greater percentage of the available herbage than under normal grazing conditions. This also is probably an important factor in overgrazed pasture lands in the plains of India.

The chief points to be borne in mind are that animals do not instinctively select toxic plants as forage, that all classes of livestock are not necessarily equally susceptible to the same poisonous plants, that not all poisonous plants are dangerous from their initial appearance on to maturity, and that in some cases the animals do acquire a depraved appetite for harmful plants especially when the fodder supply is scarce, a condition which is of frequent occurrence in many parts of India. The losses in many cases may be avoided by increasing our knowledge of these plants by a systematic study and by working out practical preventive measures.

Food poisons

Some of the plants which normally provide food and fodder for man and animals, produce deleterious effects under certain circumstances. This group of plants, which may be called " food poisons ", is of considerable importance inasmuch as it produces serious loss of life and health. The following are among the more important of food poisons : several grasses, especially 'juar' [*Sorghum vulgare* (Linn.) Pers.] and Johnson grass or 'baru' [*S. halepense* (Linn.) Pers.], 'khesari dal' (*Lathyrus sativus* Linn.), flax (*Linum usitatissimum* Linn.), mustards (species of *Brassica* and *Sinapis*, especially the 'rai'), several members of the Cucurbitaceae family, leaf blades of rhubarb (species of *Rheum*), potato (*Solanum tuberosum* Linn.), buckwheat (*Fagopyrum esculentum* Moench and *F. tataricum* Gaertn.), cotton-seed (*Gossypium* sp.), caltrop (*Tribulus terrestris* Linn.), Lima or Duffin bean (*Phaseolus lunatus* Linn.), and species of *Rumex*, *Lupinus*, *Medicago*, *Melilotus*, *Beta*, *Quercus*, etc. For details of the circumstances under which they produce harmful effects, the reader is referred to the descriptions given under individual plants. Of particular importance, however, is the development of hydrocyanic acid among certain grasses which form an important part of the food of animals. Some of these produce dangerously large quantities of the poison under certain climatic and soil conditions. The points to be remembered about these grasses are that they are dangerous during wilting and under condition of drought, that younger and more esculent ones are often more likely to contain lethal doses of hydrocyanic acid, and that if well dried these plants are generally without danger.

Unfortunately our knowledge of Indian grasses in this connection is meagre and it is not possible to estimate the losses in livestock from this source. But the problem of poisonous grasses is of economic importance of the first magnitude in certain parts of India where rains often fail and drought conditions prevail. In the recent famine in Hissar district of the Punjab, there is little doubt that in addition to ravages caused by scarcity of food, the livestock must have suffered enormously from this source.

Important Plants Poisonous to Man and Livestock (Including Food Poisons)

Below is given a list of important plants, found wild or in a state of cultivation in India, which are poisonous to man and livestock. This list is based on Chopra and Badhwar's paper on "Poisonous Plants of India" (*9*) and also includes food poisons.

Abrus precatorius Linn.
Aconitum balfourii Stapf (*A. ferox* Fl. Brit. Ind., in part)
Aconitum chasmanthum Stapf *ex* Holmes
Aconitum deinorrhizum Stapf
Aconitum elwesii Stapf [*A. uncinatum* (?) Fl. Brit. Ind., *non* Linn.]
Aconitum falconeri Stapf (*A. ferox* Fl. Brit. Ind., in part)
Aconitum ferox Wall. *ex* Ser. (*A. ferox* Fl. Brit. Ind., in part)
Aconitum laciniatum Stapf
Aconitum laeve Royle (*A. lycoctonum* Fl. Brit. Ind., *non* Linn.)
Aconitum lethale Griff. (*A. palmatum* Fl. Brit. Ind., *non* D. Don)
Aconitum luridum Hook. *f.* & Thoms.
Aconitum moschatum Stapf
Aconitum soongaricum Stapf
Aconitum spicatum Stapf (*A. ferox* Fl. Brit. Ind., in part)
Aconitum violaceum Jacquem. *ex* Stapf [*A. napellus*, var. *multifidum* and var. *rigidum* (in part), Fl. Brit. Ind.]
Actaea spicata Linn.
Acorus calamus Linn.
Adenia palmata Engl. (*Modecca palmata* Lam.)
Adonis aestivalis Linn.
Adonis chrysocyathus Hook. *f.* & Thoms.
Ailanthus altissima (Mill.) Swingle (*A. glandulosa* Desf.)
Allamanda cathartica Linn.
Alocasia montana (Roxb.) Schott
Aloe barbadensis Mill. (*A. vera* of Indian literature where Linnaeus is wrongly mentioned as the author of this plant)— also some other species of *Aloe*
Ammannia baccifera Linn.
Ammannia senegalensis Lam.
Amorphophallus sylvaticus (Roxb.) Kunth (*Synantherias sylvatica* Schott)
Anacardium occidentale Linn.
Anagallis arvensis Linn.
Anamirta cocculus (Linn.) Wight & Arn.
Ananas comosus (Linn.) Merr. (*A. sativus* Schult. *f.*)
Andrachne cordifolia Muell. Arg.

Anemone obtusiloba D. Don
Annona reticulata Linn.
Annona squamosa Linn.
Anthemis cotula Linn.
Antiaris toxicaria (Pers.) Lesch.
Apium graveolens Linn.
Aquilegia vulgaris Linn.
Areca catechu Linn.
Arenga obtusifolia Mart.
Arenga pinnata (Wurmb.) Merr. (*A. saccharifera* Labill.)
Argemone mexicana Linn.
Arisaema speciosum (Wall.) Mart.
Arisaema tortuosum (Wall.) Schott
Aristolochia bracteata Retz.
Aristolochia indica Linn.
Artemisia absinthium Linn.
Artemisia maritima Linn.
Artemisia vulgaris Linn.
Asclepias curassavica Linn.
Atropa belladonna Linn.
Azadirachta indica A. Juss. (*Melia azadirachta* Linn.)
Balanites roxburghii Planch.
Baliospermum montanum Muell. Arg. (*B. axillare* Blume)
Barringtonia acutangula (Linn.) Gaertn.
Barringtonia asiatica (Linn.) Kurz (*B. speciosa* Forst.)
Beta vulgaris Linn.
Brassica cernua (Thunb.) Forbes & Hemsley (*B. juncea* Hook. *f.* & Thoms., in part; subsp. *rugosa* Prain, var. *typica* Prain)
Brassica integrifolia (West) O. E. Schulz (*B. juncea* Hook. *f.* & Thoms., in part; subsp. *rugosa* Prain, var. *cuneifolia* Prain)
Brassica juncea (Linn.) Czernjaëw & Cosson (*B. juncea* Hook. *f.* & Thoms., in part; subsp. *juncea* Prain, var. *oleifera* Prain)
Brassica napus Linn. (*B. campestris* Linn., subsp. 1. *campestris* and subsp. 2. *napus* Hook. *f.* & T. Anders.)
Brassica nigra (Linn.) Koch
Brucea amarissima (Lour.) Merr. (*B. sumatrana* Roxb.)
Butea monosperma (Lam.) Kuntze (*B. frondosa* Koen. *ex* Roxb.)
Buxus wallichiana Baill. (*B. sempervirens* Fl. Brit. Ind., in part, *non* Linn.)
Calonyction muricatum (Linn.) G. Don (*Ipomoea muricata* Jacq.)
Calotropis gigantea (Linn.) Dryand.
Calotropis procera (Linn.) Dryand.
Caltha palustris Linn.
Camellia sinensis (Linn.) Kuntze (*C. theifera* Griff.)
Canavalia virosa Wight & Arn. [*C. ensiformis* (Linn.) DC., var. *virosa* Baker]
Cannabis sativa Linn.
Capsicum annuum Linn.
Capsicum frutescens Linn.
Carica papaya Linn.
Casearia graveolens Dalz.
Centella asiatica (Linn.) Urban (*Hydrocotyle asiatica* Linn.)
Cerebera manghas Linn. (*C. odollam* Gaertn.)

Chenopodium ambrosioides Linn.
Chenopodium botrys Linn.
Chrozophora rottleri A. Juss. *ex* Spreng. [*C. plicata* A. Hook. *f.* (*non* A. Juss.); *C. tinctoria* Hook. *f.* (*non* A. Juss.), in part]
Cicuta virosa Linn.
Cimicifuga foetida Linn.
Cinchona calisaya Wedd. (also var. *ledgeriana* Howard)
Cinchona officinalis Linn.
Cinchona succirubra Pav. *ex* Klotzsch
Cinnamomum camphora Nees & Eberm.
Citrullus colocynthis Schrad.
Citrullus vulgaris Schrad. *ex* Eckl. & Zeyh. (bitter variety)
Cleistanthus collinus Benth. & Hook *f.*
Clitoria ternatea Linn.
Coffea arabica Linn.
Colchicum luteum Baker
Convolvulus arvensis Linn.
Corallocarpus epigaeus (Rottl. & Willd.) C. B. Clarke
Coriaria nepalensis Wall.
Crinum asiaticum Linn.
Crinum defixum Ker-Gawl.
Crinum latifolium Linn.
Crocus sativus Linn.
Croton oblongifolius Roxb.
Croton tiglium Linn.
Cryptostegia grandiflora (Roxb.) R. Br.
Cucumis sativus Linn. (wild variety)
Cucumis trigonus Roxb.
Cuscuta reflexa Roxb.
Cynanchum vinceloxicum Pers.
Cytisus scoparius Link
Daphne oleoides Schreb.
Daphne papyracea Wall. *ex* Steud. (*D. cannabina* Wall., Fl. Brit. Ind., in part)
Datura metel Linn. (inclusive *D. fastuosa* Linn.)
Datura metel Linn., var. *fastuosa* (Linn.) Narayanaswami & Badhwar
Datura stramonium Linn.
Daucus carota Linn.
Delphinium brunonianum Royle (possibly some other species of *Delphinium* also)
Dendrocalamus strictus (Roxb.) Nees
Dieffenbachia seguine (Jacq.) Schott (*Arum seguine* Jacq.)
Digitalis lanata Ehrh.
Digitalis purpurea Linn.
Dioscorea deltoidea Wall. (*D. deltoidea* Fl. Brit. Ind., in part)
Dioscorea hispida Dennst. (*D. daemona* Roxb.)
Dioscorea prazeri Prain & Burkill (*D. deltoidea* Wall., var. *sikkimensis* Prain)
Diospyros montana Roxb. (*D. montana* Fl. Brit. Ind., in part)
Dodonaea viscosa (Linn.) Jacq.
Dolichandrone falcata Seem. (inclusive *D. lawii* Seem.)
Duranta repens Linn. (*D. plumieri* Jacq.)
Elaeodendron glaucum Pers. (*E. glaucum* Fl. Brit. Ind., in part)
Entada pursaetha DC. (*E. scandens* Benth.

Erigeron canadensis Linn.
Ervatamia dichotoma (Roxb.) Blatter (*Tabernaemontana dichotoma* Roxb.)
Erythroxylum coca Lam.
Eucalyptus globulus Labill.
Euphorbia acaulis Roxb. (*E. fusiformis* Buch.-Ham.)
Euphorbia antiquorum Linn.
Euphorbia helioscopia Linn.
Euphorbia hirta Linn. (*E. pilulifera* Linn.)
Euphorbia hypericifolia Linn.
Euphorbia neriifolia Linn.
Euphorbia nivulia Buch.-Ham.
Euphorbia peplus Linn.
Euphorbia pilosa Linn.
Euphorbia rothiana Spreng.
Euphorbia royleana Boiss.
Euphorbia thomsoniana Boiss.
Euphorbia thymifolia Linn.
Euphorbia tirucalli Linn.
Excoecaria agallocha Linn.
Fagopyrum esculentum Moench
Fagopyrum tataricum Gaertn.
Ficus hispida Linn. *f.*
Fleurya interrupta Gaudich.
Fritillaria imperialis Linn.
Garcinia morella Desr. (possibly some other species of *Garcinia* also)
Gaultheria fragrantissima Wall.
Girardinia heterophylla Decne. (with varieties mentioned in Fl. Brit. Ind., which are now considered as distinct species)
Gloriosa superba Linn.
Gossypium herbaceum Linn. (and other species of *Gossypium*)
Gynocardia odorata R. Br.
Hedera helix Linn.
Hippomane mancinella Linn.
Holarrhena antidysenterica Wall.
Holigarna arnottiana Hook. *f.*
Holigarna grahamii (Wight) Hook. *f.*
Holigarna longifolia Buch.-Ham. *ex* Roxb.
Hura crepitans Linn.
Hydnocarpus kurzii (King) Warb. (*Taraktogenos kurzii* King)
Hydnocarpus laurifolia (Dennst.) Sleumer (H. *wightiana* Blume)
Hyoscyamus muticus Linn.
Hyoscyamus niger Linn.
Hypericum perforatum Linn.
Inula graveolens Desf.
Ipomoea hederacea (Linn.) Jacq.
Jatropha curcas Linn.
Jatropha glandulifera Roxb.
Jatropha gossypiifolia Linn.
Jatropha multifida Linn.
Juniperus communis Linn. (and some other species of *Juniperus*)
Kalanchoe spathulata (Poir.) DC.

Lactuca tatarica C. A. Mey., var. *tibetica* Hook. *f.*
Lagenandra toxicaria Dalz.
Lagenaria vulgaris Ser. (wild variety)
Lagerstroemia indica Linn.
Lagerstroemia speciosa (Linn.) Pers. (*L. flos-reginae* Retz.)
Lantana aculeata Linn. (*L. camara* Linn.)
Laportea crenulata Gaudich.
Laportea terminalis Wight
Lasiosiphon eriocephalus Decne.
Lathyrus aphaca Linn.
Lathyrus sativus Linn.
Linaria cabulica Benth.
Linum usitatissimum Linn.
Lobelia excelsa Lesch.
Lobelia nicotianifolia Heyne
Lochnera pusilla (Murr.) K. Schum. (*Vinca pusilla* Murr.)
Lochnera rosea (Linn.) Reichb. (*Vinca rosea* Linn.)
Lolium perenne Linn.
Lolium temulentum Linn.
Luffa acutangula (Linn.) Roxb., var. *amara* C. B. Clarke
Luffa cylindrica (Linn.) M. Roem. (*L. aegyptiaca* Mill. *ex* Hook. *f.*) — wild variety
Luffa echinata Roxb.
Lycium barbarum Linn.
Madhuca latifolia (Roxb.) Macbride (*Bassia latifolia* Roxb.)
Madhuca longifolia (Linn.) Macbride (*Bassia longifolia* Linn.)
Malva parviflora Linn.
Manihot utilissima Pohl
Marsdenia lucida Edgew. *ex* Madden
Meconopsis aculeata Royle
Meconopsis napaulensis DC. (*M. wallichii* Hook., var. *fusco-purpurea* Hook. *f.*)
Medicago sativa Linn.
Melaleuca leucadendron Linn.
Melia azedarach Linn.
Melianthus major Linn.
Melilotus alba Desr.
Melilotus indica (Linn.) All. (*M. parviflora* Desf.)
Melilotus officinalis Lam.
Momordica balsamina Linn.
Momordica charantia Linn.
Momordica tuberosa Cogn. (*M. cymbalaria* Fenzl *ex* Naud.)
Moringa oleifera Lam. (*M. pterygosperma* Gaertn.)
Myristica fragrans Houtt.
Myristica malabarica Lam.
Narcissus tazetta Linn.
Nerium indicum Mill. (*N. odorum* Soland.)
Nerium oleander Linn.
Nicotiana rustica Linn.
Nicotiana tabacum Linn.
Operculina turpethum (Linn.) Silva Manso (*Ipomoea turpethum* R. Br.)
Paeonia emodi Wall.

Panicum maximum Jacq.
Papaver dubium Linn.
Papaver nudicaule Linn.
Papaver rhoeas Linn.
Papaver somniferum Linn.
Paspalum scrobiculatum Linn.
Peganum harmala Linn.
Phaseolus lunatus Linn.
Physochlaina praealta Miers
Phytolacca acinosa Roxb.
Pieris ovalifolia D. Don
Pinus longifolia Roxb. (and other pines)
Pithecellobium bigeminum Mart. (*Pithecolobium bigeminum* Benth.)
Plesmonium margaritiferum (Roxb.) Schott
Plumbago indica Linn. (*P. rosea* Linn.)
Plumbago zeylanica Linn.
Plumeria acuminata Ait. (*P. acutifolia* Poir.)
Podophyllum hexandrum Royle (*P. emodi* Wall. *ex* Hook. *f.* & Thoms.)
Polygonum hydropiper Linn. (and some other species of *Polygonum* also)
Primula reticulata Wall.
Prunus amygdalus Batsch (bitter variety)
Prunus armeniaca Linn. (bitter variety)
Prunus persica (Linn.) Stokes
Prunus undulata Buch.-Ham.
(possibly some other species of *Prunus* also)
Psychotria ipecacuanha Stokes
Punica granatum Linn.
Pyrus malus Linn. (possibly some other species of *Pyrus* also)
Quercus sp.
Randia dumetorum Lam.
Ranunculus arvensis Linn.
Ranunculus sceleratus Linn.
(possibly some other species of *Ranunculus* also)
Rauwolfia serpentina Benth. *ex* Kurz
Rheum emodi Wall. (possibly some other species of *Rheum* also)
Rhododendron arboreum Sm.
Rhododendron campanulatum D. Don
Rhododendron cinnabarinum Hook. *f.*
(some more species of *Rhododendron* are likely to be poisonous)
Rhus insignis Hook. *f.*
Rhus punjabensis J. L. Stew. *ex* Brand.
Rhus succedanea Linn.
Rhus wallichii Hook. *f.*
Ricinus communis Linn.
Rubus moluccanus Linn.
Rumex acetosa Linn.
Rumex acetosella Linn.
Ruta graveolens Linn., var. *angustifolia* Hook. *f.*
Ruta tuberculata Forsk.
Salvadora oleoides Decne.
Sambucus ebulus Linn.
Sambucus nigra Linn.
Sapindus emarginatus Vahl (*S. trifoliatus* Fl. Brit. Ind., in part, *non* Linn.)
Sapindus mukorossi Gaertn.

Sapindus trifoliatus Linn. (*S. trifoliatus* Fl. Brit. Ind., in part)
Sapium indicum Willd.
Sapium insigne Trimen
Saponaria vaccaria Linn.
Sarcostemma acidum (Roxb.) Voigt (*S. brevistigma* Wight & Arn.)
Sauromatum guttatum (Wall.) Schott
Schleichera oleosa (Lour.) Merr. (*S. trijuga* Willd.)
Scilla indica Baker
Scopolia anomala (Link & Otto) Airy-Shaw (*S. lurida* Dun.)
Secamone emetica R. Br.
Semecarpus anacardium Linn. *f.*
Semecarpus travancoricus Bedd.
Senecio vulgaris Linn. (probably some other species of *Senecio* also)
Sesamum orientale Linn. (*S. indicum* Linn.)
Sida rhombifolia Linn.
Sinapis alba Linn. (*Brassica alba* Boiss.)
Skimmia laureola Sieb. & Zucc. *ex* Walp.
Solanum dulcamara Linn.
Solanum incanum Linn. (*S. coagulans* Forsk.; *S. melongena* Linn., var. *insana* Prain ?)
Solanum nigrum Linn.
Solanum spirale Roxb.
Solanum tuberosum Linn.
Sophora mollis R. Grah.
Sophora tomentosa Linn.
Sorghum halepense (Linn.) Pers. (*Andropogon halepensis* Brot.)
Sorghum saccharatum Pers. (*Andropogon saccharatus* Kunth, *non* Roxb.)
Sorghum vulgare (Linn.) Pers. (*Andropogon sorghum* Brot.)
Stachytarpheta jamaicensis (Linn.) Vahl, var. *indica* H. J. Lam (*S. indica* Vahl)
Steudnera virosa (Kunth) Prain (*Colocasia virosa* Kunth)
Stipa sp. (possibly some)
Strychnos colubrina Linn.
Strychnos nux-vomica Linn.
Suaeda fruticosa Forsk.
Tacca pinnatifida Forst.
Taxus baccata Linn.
Terminalia bellirica (Gaertn.) Roxb.
Thevetia peruviana (Pers.) Merr. (*T. nereifolia* A. Juss. *ex* Steud.)
Thomsonia napalensis Wall.
Tragia bicolor Miq.
Tragia involucrata Linn. (with varieties which are now regarded as distinct species)
Trianthema pentandra Linn.
Trianthema portulacastrum Linn. (*T. monogyna* Linn.)
Tribulus terrestris Linn.
Trichosanthes bracteata (Lam.) Voigt (*T. palmata* Roxb.)
Trichosanthes cucumerina Linn.
Trichosanthes dioica Roxb.
Trifolium pratense Linn.
Trifolium repens Linn.
Triticum aestivum Linn. (*T. vulgare* Vill.)
Tylophora fasciculata Buch.-Ham. *ex* Wight

Tylophora indica (Burm. *f.*) Merr. (*T. asthmatica* Wight & Arn.)
Typhonium trilobatum (Linn.) Schott
Urginea coromandeliana Hook. *f.*
Urginea indica Kunth
Urtica dioica Linn.
Urtica hyperborea Jacquem. *ex* Wedd.
Urtica parviflora Roxb.
Urtica pilulifera Linn.
Verbascum thapsus Linn.
Vicia sativa Linn.
Walsura piscidia Roxb.
Wikstroemia indica (Linn.) C. A. Mey., var. *viridiflora* (Meissn.) Hook. *f.*
Withania somnifera Dun.
Xanthium strumarium Linn.
Zanonia indica Linn.
Zea mays Linn.

Indirect poisoning

Human beings and animals may become poisoned indirectly by (*a*) eating the flesh of animals that have died from the effects of poisoning by plants; (*b*) taking the milk of poisoned animals; and (*c*) eating honey prepared by bees from visits to flowers of poisonous plants.

Flesh of poisoned animals

Whether the carcass, or any part thereof, of an animal which has died from the effects of a poisonous plant is edible or not depends as to how the animal had been poisoned. If the poison had been introduced orally, the flesh can be eaten with safety. But it is advisable to discard, as a rule, the excretory organs, as there is a likelihood of the presence of the poison in dangerous amounts. This is, because, as a natural defence of the system, certain organs, soon after a harmful substance is introduced into the body, exert their utmost power to get rid of the poison. Thus the stomach and the intestines, kidneys, liver, udder, and the lungs should be discarded. In case the animal received the poison subcutaneously and intramuscularly, as happens when it is killed by poisoned arrows or abrus poisoning, etc., all the flesh except the part immediately surrounding the point where the poison is introduced, may be eaten but the excretory organs should be discarded. It is likely, however, that in case where the animal, whose flesh is eaten, is much more resistant to the poison concerned than the animal or human beings who eat the flesh, poisoning symptoms might ensue.

Effect of plants on milk

The subject of plants affecting the quantity or quality of milk supply by domestic animals occupies a prominent place in the economy of nations. A number of plants, if eaten by livestock, are known to improve the yield or quality of milk produced by them. The cotton-seeds (*Gossypium* sp.) and the mustard-seed cake (*Brassica* sp.) are well-known examples, and are commonly fed to cattle in India. There is a plentiful supply of aromatic fodder at high altitudes in the Himalayas and Trans-Himalayan regions in the summer season, and the yaks

in consequence of eating this herbage yield milk with a fragrant odour which is very much appreciated by the local people. Cows partaking of a sufficient quantity of violets or 'banafsha' (*Viola* sp.) are believed in India to yield milk which has beneficial qualities imparted by the flowers, which have medicinal properties. Many plants, on the other hand, adversely influence the yield of milk of animals which eat them, reducing its volume or affecting its quality. The milk may be affected so far as its fat content is concerned or acquire an unpleasant flavour which renders it unfit for human consumption. Even the butter made from it may become unpalatable on account of the peculiar flavour imparted to it. There are other plants the toxic constituents of which may render the milk deleterious. All purgatives of the anthracene group, such as aloes (*Aloe* sp.), senna (*Cassia* sp.), podophyllum (*Podophyllum* sp.), rhubarb (*Rheum* sp.), and cascara (*Rhamnus* sp.), are excreted in milk and are liable to give rise to purgation when such milk is consumed. Amongst other highly poisonous plants whose active principles are excreted in the milk, species of the genera *Strychnos*, *Atropa*, *Nicotiana*, *Cinchona*, and *Colchicum* may be mentioned. A case is on record where an infant at the breast suffered from symptoms of strychnine poisoning as a result of medicinal administration of strychnine to the mother, who remained unaffected. The amount of the poison excreted through this channel is very small, and unless the poison in question is very potent there may not be much danger. It is advisable, however, to discard the milk from all animals suffering from poisoning.

Milk of poisoned animals

Plants affecting quantity or quality of milk

Our knowledge of Indian plants capable of adversely affecting the volume or quality of milk is meagre, but the following instances, besides those mentioned above, are sufficient to show that research could profitably be taken up in this direction.

(*i*) *Achillea millefolium* Linn. (milfoil, yarrow) of the Western Himalayas contains a bitter volatile oil and a bitter principle named achillein. This plant when eaten by cows is stated to impart a bitter taste and strong odour to the dairy products.

(*ii*) The milk and other dairy products of cows and buffaloes grazing upon garlic (*Allium sativum* Linn.) acquire a "garlic" flavour. Cases are also known where garlic has seriously "tainted" the flesh of animals eating it. Several other species of *Allium* have a similar deleterious effect on the milk.

(*iii*) *Caltha palustris* Linn. (marsh marigold) of the temperate Western Himalayas reduces the volume of milk production in cows eating this herb (*10*).

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(*iv*) According to some authors, species of *Equisetum* (horsetails) reduce milk production or cause it to stop altogether.

(*v*) The milk of cows eating *Oxalis acetosella* Linn. (common wood sorrel) of the temperate Himalayas is with difficulty converted into butter (*10*).

(*vi*) The leaves of oaks (*Quercus* sp.) are stated to reduce or bring about an entire cessation of milk production in cattle.

(*vii*) Species of *Ranunculus* (buttercups) are stated to give rise to reddish or bitter milk. *R. sceleratus* Linn. (celery-leaved buttercup) growing in marshy areas of Bengal, Northern India, and the Himalayas causes a falling off in the yield of milk (*10*).

(*viii*) In addition to the above-mentioned plants, *Anthemis cotula* Linn. (stinking mayweed), *Artemisia absinthium* Linn. (wormwood), *Hyoscyamus niger* Linn. (henbane), and *Matricaria chamomilla* Linn. (wild chamomile) are also stated to affect the milk deleteriously, and in some cases the butter made from it. All these plants are found in India.

Honey from poisonous flowers

Poisoning from honey, collected by the bees from flowers of poisonous plants, has been reported in literature since very early times. Such opinion is also held by local people even to this day due to the fact that cases of poisoning have sometimes occurred through eating honey. Thus honey prepared from species of *Rhododendron*, *Melianthus major* Linn., species of *Datura*, etc., has often been mentioned as poisonous. The symptoms of honey poisoning would obviously vary according to the plants from which it is collected by the bees.

PREVENTION OF POISONING WITH PLANTS

The question now arises as to what should be done to prevent poisoning by plants. The adage " prevention is better than cure " is applicable to the problem of plant poisoning with just as much force as in any other sphere. Often cases are brought to notice when the symptoms have developed and the poison already circulating in the blood stream has done irreparable damage to the system. Increased knowledge of poisonous plants is the first preventive step in this direction and is sure to have an effect in decreasing fatalities among human beings and livestock.

Care of animals

Keeping the animals away as far as possible from dangerous areas and exercising special care during periods of drought or scarcity is likely to decrease the mortality amongst livestock.

Eradication of plants

Eradication of poisonous plants is a difficult matter, involving an enormous amount of labour and capital, but wherever and whenever possible it should be resorted

to. This depends upon the habit of the particular plant. Such plants may be annual, biennial or perennial herbs, or shrubs or trees. Annuals complete their life cycle within one year; these should be pulled out or dug out before seeding. Biennials require two years to complete their life cycle, growing one year, and flowering and fruiting in the second; these may be dealt with in the same way as the annuals. Perennial herbs last several years, not perishing normally after once flowering and fruiting; the aboveground portion dies each year but the root persists. These are propagated both by seeds and by underground organs, such as tubers, rootstocks, bulbs, etc., and may be dug out if not deeply rooted. Shrubs are woody perennials and should be cut down or dug out. Cutting down of lower branches of trees within the reach of animals or children is also advocated.

Indiscriminate importation

The indiscriminate importation of ornamental plants has recently increased the number of poisonous plants in India. Some of these do not find much competition in their adopted home and are spreading or are likely to spread in this country at an enormously rapid pace. The time perhaps is not yet ripe to agitate for a law prohibiting the importation of poisonous plants for gardens or to take measures to forbid the cultivation of those already introduced, but sooner or later it may have to be considered. In the meantime an appeal may be made to the good sense of the people to limit such practices as far as possible. Clippings and trimmings of poisonous plants from gardens and shrubberies should not be carelessly thrown out, but should be burnt to avoid animals having access to them.

Adulteration

The foodstuff dealers should make sure that adulteration is not practised either with poisonous plants, or with plants whose properties are doubtful. Recent work (*11*) in connection with the causation of epidemic dropsy, at the Calcutta School of Tropical Medicine, has shown that in some epidemics mustard oil adulterated with 'katakar' oil from the seeds of *Argemone mexicana* Linn., the Mexican poppy or 'shialkata', was the cause of the outbreak.

2.—Plants poisonous to insects and fishes

INSECTICIDAL PLANTS

The second group of poisonous plants includes those which are poisonous to insect pests. The finding of cheap insecticides for the diverse needs of agriculture, destruction of household pests, and prevention of vectors of such diseases as malaria and many others borne by insects is a very important problem, and one to which a good

Losses due to insects

deal of attention has been paid in recent years. It would be no great exaggeration to say that insects have been responsible for more loss of life and destruction of property than that caused by wars, floods, earthquakes, fires, and famines in the history of man. Advances in civilization are producing conditions suitable for insect multiplication in many places, in spite of all efforts to the contrary. On a moderate computation the annual loss caused to India through insect pests has been put at 2,000 millions of rupees and over a million and a half of human lives. An effective defence against these enemies of social and economic progress will materially reduce this enormous wastage and facilitate national development. One of the necessities for combating this menace is to find cheap and effective insecticides, commensurate with the means of the great masses in India whose economic condition is very low. At the present time our knowledge of plants bearing insecticidal properties in this country is very meagre indeed. A thorough inquiry into this aspect of poisonous plants is, therefore, of prime importance to the country. For several reasons vegetable insecticides are preferable to the mineral ones, such as arsenicals, copper compounds, mineral oils, etc. Those from vegetable sources are undoubtedly less deleterious to human beings and other warm-blooded animals generally, and they are also less harmful from the point of view of agriculture. Further, most of the mineral insecticides at the present time are being imported from foreign countries and are, therefore, expensive. So far as the insecticides from the plant kingdom are concerned, so little is known in this country that we have to depend on those growing in other countries. The larger the number of effective insecticides we discover from among the poisonous plants, the greater will be the chances of their being brought into extensive use by the people for medical, veterinary, agricultural, and household purposes.

Need for effective defence

Important insecticidal plants

Among vegetable insecticides of proved value may be mentioned *Chrysanthemum* (pyrethrum), *Derris* (tuba root), *Nicotiana* (tobacco), *Tephrosia*, *Picrasma* (quassia), *Delphinium* (larkspur), *Veratrum*, etc. Amongst these, *Chrysanthemum cinerariifolium* Vis. and *Derris elliptica* (Roxb.) Benth. have acquired great importance as plant insecticides during the last 15 years; the United States alone is annually importing several millions of dollars worth of these commodities. On account of the effectiveness of the flower-heads of *C. cinerariifolium* in destroying insects and mosquito larvae, Japan, Kenya, and some other countries have taken up the cultivation of this plant and are reaping enormous profits by exporting them to other countries. In India, its cultivation has been attempted only very recently, and there is every likelihood of this

country soon occupying a prominent position amongst the pyrethrum-producing countries of the world. A series of samples analyzed by the authors from material grown in Kashmir and the Murree Hills were found to be of as high a quality as any produced elsewhere. *Derris elliptica* is found wild to a very limited extent in India. Roots from plants cultivated in Mysore have been found to contain a high percentage of rotenone, one of the important insecticidal constituents occurring in the plant. Several allied species found in India need investigation. Of these, *Derris ferruginea* (Roxb.) Benth. has recently been shown to contain rotenone and may prove to be a good insecticide. Tobacco is largely cultivated in India. *Tephrosia vogelii* Hook. *f.* has been shown in foreign countries to be an efficient insecticide for fleas, lice, and ticks, and it has been suggested that it may be used as a cheap commercial dip for cattle. Some other species of *Tephrosia* are also stated to have insecticidal properties, but several of the Indian species although met with in abundance remain yet uninvestigated. Indian species of *Picrasma* also need investigation, and we have been informed that powdered young leaves and twigs of *P. javanica* Blume, var. *nepalensis* (Benn.) Badhwar (*P. nepalensis* Benn.) are used to kill mosquito larvae in Assam. Several Indian species of *Delphinium* are even now used for destroying maggots in wounds and may be potential insecticides. Furthermore, it has been stated that the alkaloid cytisine is an important constituent of the Persian and Australian insect powder. This alkaloid, which resembles nicotine in its action, has been found in at least six genera of which *Euchresta* and *Sophora* are represented in India.

Control of mosquito larvae

Hackett, Russell and others (*12*) discuss the naturalistic methods in practice for the control of mosquito larvae and refer to the role of the plant kingdom for this purpose. It is stated that pollution by vegetable matter in the form of industrial wastes has often been tried with success as an antimalarial measure. Bagasse from sugar-cane mills in the Philippines in one reported case seemed to be keeping a stream free from *Anopheles flavirostris*; the refuse from the Government Sisal Experiment Station is said to have a similar action, and numerous large pits used for macerating canepa hemp in Italy did not breed anophelines. Stagnant pools, such as engineering borrow-pits into which green-cut vegetation has been thrown are stated to breed culicines only, as no anophelines were found. The lethal effect of a fortnight-old brew of cut grass is said to be remarkable. The extension of this method in the form of "herbage-packing" to shallow, small volume, running channels has been advocated by Williamson and these authors. They are of opinion that the effect of this is not mechanical but

biological and consider the use of green-cut vegetation only, for dry straw results in a hay infusion, favourable to larval growth. It is not every plant, however, that is suitable for use in running water. According to these authors: "The best so far found in India are *Cleistanthus* species and *Holorrhena antidysenterica* (*sic*). The first of these are fish poisons; the latter contains several alkaloids". We are confident, however, that many more plants mentioned in this work would be found to be equally good or even better for this purpose, but the piscicidal plants must be employed with caution, since it is inadvisable to use them if the water contains fishes or drains into tanks or reservoirs containing such animal life.

INSECT-REPELLENT PLANTS

The importance of insect repellents also occupies a prominent place in the economy of nations. Here again the cheaper and larger the number of effective insect repellents that could be used from amongst plants growing in India, the greater the likelihood of the masses of India benefiting from their use. The leaves of neem (*Azadirachta indica* A. Juss.) and of patchouli (*Pogostemon heyneanus* Benth., syn. *P. patchouli* Fl. Brit. Ind., *non* Pellet.), and the roots of costus (*Saussurea lappa* C. B. Clarke) are used to protect woollen fabrics from insects. Articles placed in boxes made of sandalwood (*Santalum album* Linn.) are immune from the attacks of these pests. Some essential oils, such as the eucalyptus oil from *Eucalyptus globulus* Labill. and citronella oil from *Cymbopogon nardus* (Linn.) Rendle (*Andropogon nardus* Linn.), when applied to the body, give relief from the bites of mosquitoes so long as the odour lasts. Hemp (*Cannabis sativa* Linn.), if spread under a bedsheet, affords ample protection against the fleas which disturb sleep at night in many of the hill stations of India. The simple device of mixing of the leaves of *Trigonella foenum-graecum* Linn. and of *Vitex negundo* Linn., etc., with the grains before storage, especially in rainy weather, as practised by the agriculturists in some parts of this country, saves the produce from the ravages of insects. Investigation of suitable plants which, when grown, will keep away mosquitoes from the habitations has been engaging the attention of malariologists for some time. No really effective plant for this purpose has so far been discovered, but it may be worth-while giving extended trials to the shrubby basil (*Ocimum gratissimum* Linn.), absinthe (*Artemisia absinthium* Linn.), and other plants which diffuse strong fragrance in the surrounding atmosphere. The use of repellent sprays for protecting cattle from the attacks of flies constitutes, at the present time, an integral part of daily practice in the progressive countries of the world, although opinion would appear to be still divided as to whether the protection thus

afforded results in an actual increase in the yield of milk. Sen (*13*) reports that the use of a spray consisting of high-speed Diesel oil, "Pyrocide 20" (a concentrated extract of pyrethrum flowers), and pine oil, when applied on Sahiwal cows for 21 consecutive days proved very effective against some species of biting flies and resulted in an appreciable increase in the yield of milk.

Indian Resources

Investigation of vegetable insecticides and insect repellents from among the vast potential resources existing in this country will repay scrutiny. According to Chopra, Badhwar and Goswami (*14*), the following plants growing wild or in a state of cultivation in India are reported to possess insecticidal or insect-repellent properties. In addition to these, a number of essential-oil-bearing plants may also be usefully investigated.

Acorus calamus Linn.
Acorus gramineus Soland.
Adina cordifolia (Roxb.) Benth. & Hook. *f.*
Agave americana Linn.
Anacardium occidentale Linn.
Anamirta cocculus (Linn.) Wight & Arn.
Andrachne cordifolia Muell.Arg.
Annona reticulata Linn.
Annona squamosa Linn.
Arisaema speciosum (Wall.) Mart.
Arisaema tortuosum (Wall.) Schott
Aristolochia bracteata Retz.
Artemisia absinthium Linn.
Azadirachta indica A. Juss. (*Melia azadirachta* Linn.)
Bambusa arundinacea Willd.
Butea monosperma (Lam.) Kuntze (*B. frondosa* Koen. *ex* Roxb.)
Calonyction muricatum (Linn.) G. Don (*Ipomoea muricata* Jacq.)
Cannabis sativa Linn.
Cassytha filiformis Linn.
Centratherum anthelminticum (Willd.) Kuntze (*Vernonia anthelmintica* Willd.)
Chrysanthemum cinerariifolium Vis.
Chrysanthemum coccineum Willd.
Cimicifuga foetida Linn.
Cinnamomum camphora Nees & Eberm.
Croton oblongifolius Roxb.
Croton tiglium Linn.
Cucumis sativus Linn. (wild variety)
Curcuma longa Roxb.
Cymbopogon nardus (Linn.) Rendle (*Andropogon nardus* Linn.)
Cynanchum arnottianum Wight
Delphinium brunonianum Royle
Delphinium caeruleum Jacquem. *ex* Cambess.
Delphinium elatum Linn.
Derris elliptica (Roxb.) Benth. (possibly some other species of *Derris* also)

Duranta repens Linn. (*D. plumieri* Jacq.)
Eucalyptus globulus Labill.
Euphorbia antiquorum Linn.
Euphorbia thymifolia Linn.
Gardenia campanulata Roxb.
Gaultheria fragrantissima Wall.
Gloriosa superba Linn.
Gynandropsis gynandra (Linn.) Merr. (*G. pentaphylla* DC.)
Hedera helix Linn.
Kalanchoe spathulata (Poir.) DC.
Lagenandra toxicaria Dalz.
Madhuca latifolia (Roxb.) Macbride (*Bassia latifolia* Roxb.)
Madhuca longifolia (Linn.) Macbride (*Bassia longifolia* Linn.)
Melaleuca leucadendron Linn.
Millettia auriculata Baker *ex* Brand.
Nicandra physaloides Gaertn.
Nicotiana rustica Linn.
Nicotiana tabacum Linn.
Nigella sativa Linn.
Ocimum gratissimum Linn.
Pachygone ovata (Poir.) Miers *ex* Hook. *f.* & Thoms.
Peganum harmala Linn.
Picrasma javanica Blume, var. *nepalensis* (Benn.) Badhwar (*P. nepalensis* Benn.)
Pieris ovalifolia D. Don
Pogostemon heyneanus Benth. (*P. patchouli* Hook. *f.* in Fl. Brit. Ind., *non* Pellet.)
Polygonum flaccidum Meissn.
Polygonum hydropiper Linn.
Randia dumetorum Lam.
Ricinus communis Linn.
Ruta graveolens Linn.
Santalum album Linn.
Sarcostemma acidum (Roxb.) Voigt (*S. brevistigma* Wight & Arn.)
Saussurea lappa C. B. Clarke
Schleichera oleosa (Lour.) Merr. (*S. trijuga* Willd.)
Scleria pergracilis (Nees) Kunth
Sophora mollis R. Grah.
Tephrosia vogelii Hook. *f.*
Trigonella foenum-graecum Linn.
Vitex negundo Linn.
Zanthoxylum hamiltonianum Wall.

PLANTS POISONOUS TO FISHES

That there are many plants in the Indian flora which have a deleterious effect on fishes is well known. Wholesale poisoning of fish in ponds, streams, and pools by means of these plants is very uneconomical and is not allowed in any civilized country, but cases are known where such plants have come into contact with water and enormous numbers of fish have died as a result. This aspect, though not very important, cannot entirely be left out of consideration in any study of poisonous

plants. The list of plants growing in India having a poisonous action on fishes is very long and a large number of them are mentioned by Chopra in his book "Indigenous Drugs of India". Lately, however, considerable additions have been made to this list. This group is of importance, as some of the insecticides are also piscicides and *vice versâ*, and a systematic investigation of this group may lead to the discovery of effective insecticides, which is the crying need of this country at the present time. According to Chopra, Badhwar and Nayar (*15*), the following plants growing wild or in a state of cultivation in India are reputed as fish poisons.

Acacia pennata (Linn.) Willd.
Acronychia pedunculata (Linn.) Miq. (*A. laurifolia* Blume)
Agave americana Linn.
Albizzia chinensis (Osbeck) Merr. (*A. stipulata* Boiv.)
Albizzia procera (Roxb.) Benth.
Anagallis arvensis Linn.
Anamirta cocculus (Linn.) Wight & Arn.
Annona squamosa Linn.
Apama tomentosa Engl. (*Bragantia tomentosa* Blume)
Arenga obtusifolia Mart.
Artemisia vulgaris Linn.
Asclepias curassavica Linn.
Balanites roxburghii Planch.
Barringtonia acutangula (Linn.) Gaertn.
Barringtonia asiatica (Linn.) Kurz (*B. speciosa* Forst.)
Barringtonia racemosa (Linn.) Roxb.
Berberis aristata DC. (possibly some other species of *Berberis* also)
Caesalpinia nuga (Linn.) Ait.
Callicarpa longifolia Lam., var. *lanceolaria* C. B. Clarke
Calophyllum inophyllum Linn.
Cannabis sativa Linn.
Careya arborea Roxb.
Casearia graveolens Dalz.
Casearia tomentosa Roxb.
Cerbera manghas Linn. (*C. odollam* Gaertn.)
Cinchona calisaya Wedd. (also the var. *ledgeriana* Howard)
Cinchona officinalis Linn.
Cinchona succirubra Pav. *ex* Klotzsch
Cleistanthus collinus Benth. & Hook. *f.*
Corypha umbraculifera Linn.
Croton oblongifolius Roxb.
Croton tiglium Linn.
Cyclamen persicum Mill.
Dalbergia stipulacea Roxb.
Derris elliptica (Roxb.) Benth.
Derris ferruginea (Roxb.) Benth. (possibly)
Derris scandens (Roxb.) Benth.
Derris trifoliata Lour., var. *uliginosa* (Roxb. *ex* Willd.) Badhwar (*D. uliginosa* Benth.) *Robinia uliginosa* Roxb. *ex* Willd.)

Dioscorea hispida Dennst. (*D. daemona* Roxb.)
Dioscorea prazeri Prain & Burkill (*D. deltoidea* Wall., var. *sikkimensis* Prain)
Diospyros ebenum Koen.
Diospyros montana Roxb. (*D. montana* Fl. Brit. Ind., in part)
Diospyros paniculata Dalz.
Dodonaea viscosa (Linn.) Jacq.
Dolichandrone falcata Seem.
Edgeworthia gardneri Meissn.
Entada pursaetha DC. (*E. scandens* Benth.)
Eremostachys superba Royle *ex* Benth.
Eremostachys vicaryi Benth.
Eupatorium odoratum Linn.
Euphorbia antiquorum Linn.
Euphorbia neriifolia Linn.
Euphorbia royleana Boiss.
Euphorbia tirucalli Linn.
Excoecaria agallocha Linn.
Fluggea leucopyrus (Koen.) Willd.
Fluggea virosa (Roxb. *ex* Willd.) Baill. (*F. microcarpa* Blume)
Gardenia campanulata Roxb.
Gnetum scandens Roxb.
Gynandropsis gynandra (Linn.) Merr. (*G. pentaphylla* DC.)
Gynocardia odorata R. Br.
Harpullia cupanioides Roxb. (*H. cupanoides* Fl. Brit. Ind., in part)
Hydnocarpus kurzii (King) Warb. (*Taraktogenos kurzii* King)
Hydnocarpus laurifolia (Dennst.) Sleumer (*H. wightiana* Blume)
Hydrocotyle javanica Thunb.
Jatropha curcas Linn.
Juglans regia Linn.
Lasiosiphon eriocephalus Decne.
Lepidium draba Linn.
Linostoma decandrum Wall.
Madhuca latifolia (Roxb.) Macbride (*Bassia latifolia* Roxb.)
Madhuca longifolia (Linn.) Macbride (*Bassia longifolia* Linn.)
Maesa indica Wall.
Melodinus monogynus Roxb.
Millettia auriculata Baker *ex* Brand.
Millettia pachycarpa Benth.
Millettia piscidia Wight & Arn.
Mundulea sericea (Willd.) Greenway (*M. suberosa* Benth.)
Myrica nagi Thunb.
Ougeinia dalbergioides Benth.
Pachygone ovata (Poir.) Miers *ex* Hook. *f.* & Thoms.
Phyllanthus urinaria Linn.
Pithecellobium bigeminum Mart. (*Pithecolobium bigeminum* Benth.)
Polygonum flaccidum Meissn. } (possibly some other species of *Polygonum* also)
Polygonum hydropiper Linn. }
Pongamia pinnata (Linn.) Merr. (*P. glabra* Vent.)
Pygeum gardneri Hook. *f.*
Randia dumetorum Lam.
Randia uliginosa DC.

Rauwolfia serpentina Benth. *ex* Kurz
Rhododendron barbatum Wall. *ex* G. Don
Rhododendron falconeri Hook. *f.*
Ricinus communis Linn.
Sapindus mukorossi Gaertn.
Sapindus trifoliatus Linn. (*S. trifoliatus* Fl. Brit. Ind., in part)
Sapium indicum Willd.
Scilla (possibly some species)
Sphaeranthus indicus Linn.
Stephania hernandiifolia (Willd.) Walp.
Strychnos colubrina Linn. (*S. colubrina* Fl. Brit. Ind., in part; *S. beddomei* C. B. Clarke, in part)
Strychnos nux-vomica Linn.
Taxus baccata Linn.
Tephrosia candida (Roxb.) DC.
Tephrosia purpurea (Linn.) Pers.
Terminalia bellirica (Gaertn.) Roxb.
Thevetia peruviana (Pers.) Merr. (*T. nereifolia* A. Juss. *ex* Steud.)
Urginea (possibly some species)
Verbascum thapsus Linn.
Walsura piscidia Roxb.
Wikstroemia indica (Linn.) C. A. Mey., var. *viridiflora* (Meissn.) Hook. *f.*
Zanthoxylum alatum Roxb.
Zanthoxylum hamiltonianum Wall. } (possibly some other species of *Zanthoxylum* also)

XII.—CLASSIFICATION OF POISONOUS PLANTS

Poisonous plants have been classified in a number of ways; the commonly accepted classifications are as follows :—

1.—According to chemical constituents

Poisonous plants may be classified according to their chemical constituents, that is, into alkaloidal groups, glucosidal groups, etc. It is, however, known that the toxic properties of a plant may be due to one or several similar or dissimilar chemical constituents, and if this mode of classification is adopted, there would be considerable overlapping.

2.—According to physiological action

Poisons produce their harmful effects on the organism in a number of ways, and according to some it would appear to be best to classify them according to their physiological action. One such classification in which poisons have been grouped according to the organs on which they act and the symptoms they may produce is :—

Irritant poisons

I. Plants of the irritant group set up inflammation of the part with which they come in contact. If these are swallowed, they irritate the whole of the gastro-intestinal tract, producing pain, nausea, vomiting, purging, and even delirium, coma, collapse, and death. The

irritants have been subdivided according to the severity of their action into (*a*) *simple irritants*, which merely set up inflammation, such as several plants containing essential oils, saponins, and resins, and (*b*) *corrosives*, which produce destruction of the tissues ; if taken internally, they give rise to bloody vomit. Fortunately the majority of vegetable poisons do not come under this category.

Neuro-muscular poisons

II. Nerve and muscle poisons act on the neuro-muscular organs, and to this group belong many powerful poisons, such as alkaloids and glucosides, which produce serious effects in minute quantities. This group includes (*a*) those which cause intense stimulation of the nervous system producing spasms or convulsions, *e.g.*, strychnine from *Strychnos nux-vomica* Linn., picrotoxin from *Anamirta cocculus* (Linn.) Wight & Arn., atropine from *Atropa belladonna* Linn., etc. ; they quicken the onset of *rigor mortis* ; (*b*) those which produce marked depression such as narcosis causing deep sleep or coma or paralysis of parts, *e.g.*, morphine from *Papaver somniferum* Linn. ; and (*c*) those which act directly on the heart and are cardiac poisons, *e.g.*, digitalis, strophanthus, etc.

Blood poisons

III. Blood poisons are those which act directly on the constituents of the blood, *e.g.*, the corpuscles, the haemoglobin contained in them, and the constituents of the blood plasma. They may produce cyanosis, ecchymosis, discoloration of the skin, etc. The changes produced by some of them can easily be detected by means of spectroscopic examination of the blood. Amongst examples of blood poisons may be mentioned the toxalbumins, ricin from *Ricinus communis* Linn., crotin from *Croton tiglium* Linn., abrin from *Abrus precatorius* Linn., etc., and hydrocyanic acid from cyanogenetic-glucoside-containing plants, such as *Prunus* sp.

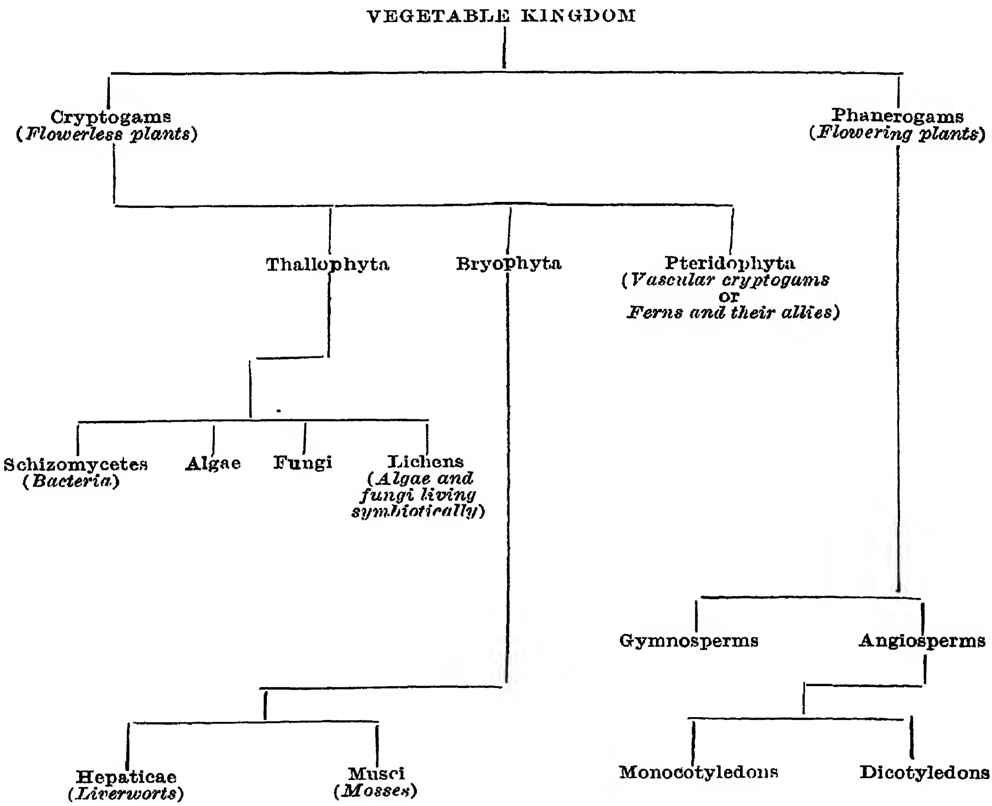
The action of the poisons is however complex, a number of different organs being affected. As a rule the action is not confined to the class of structures on which they act directly. The functions of the vital organs are so dependent on each other that if the action of one is disturbed all others also become affected. The final cause of death is either interference with respiration and production of asphyxia or interference with the action of the heart and its stoppage. The action of the irritant poisons is most evident in *post-mortem* examination. With other poisons the results of the autopsy may not be so evident.

3.—According to botanical system

Each of the above classifications has its own advantages and disadvantages. None of these can be subdivided into groups that are mutually exclusive and all-inclusive. Besides, there are many

plants, which, though known to be poisonous, have not been investigated chemically and pharmacologically. Adoption of the above classifications would lead to a good deal of overlapping and repetition, and additions of imperfectly known or unknown groups. We, therefore, adopt the botanical classification which seems to be the most satisfactory.

Numerous representatives of the vegetable kingdom present such an infinite variety of form that it would be impossible to study them without first arranging them into some sort of groups or classes, *i.e.*, without classifying them. Botanists, therefore, have found a refuge from this hopeless confusion by classifying them into different divisions, classes, orders, families, etc., with morphology as the basis of classification. For the purpose of this book, the vegetable kingdom may be divided into the following main groups which are further subdivided into smaller divisions :—



The botanical and toxicological aspects of the various groups of the vegetable kingdom are discussed in the following pages.

which are found in stagnant waters have, however, been reported to produce poisoning in man, livestock, and even fishes. The normally offensive odour of water may be sufficient to indicate their presence, but only a microscopic examination can determine just what forms of algae are present. Several workers have shown that when odours in water are pronounced, microscopic organisms are present in considerable numbers. According to Parker, quoted by Pammel (*16*), of the organisms which produce objectionable and deleterious qualities in waters, the microscopic ones are the most important, and very few cases have been observed in which really serious trouble in water supplies could be attributed directly to the growth of larger plants.

Blue-green algae

"Water bloom"

Deleterious effects

Of the algae that produce poisoning, the blue-green algae (Myxophyceae or the Cyanophyceae), as a group, are perhaps the most pronounced in their toxic effects. They are found in various situations and are always present in all kinds of open collections of water, *e.g.*, tanks, ponds, pools, lakes, reservoirs, etc. Often they multiply in great abundance to form a sort of scum on the surface of water and exhibit themselves in the form of a " bloom ". These " water blooms " on the surface of lakes, ponds, and other open sheets of water, which are mainly due to the presence of blue-green algae in large numbers, are distasteful to bathers and obnoxious to those living in the vicinity, since the bloom algae, on death and decomposition, produce a disagreeable taste and foul odour in the water. Even when alive they produce objectionable smells. Apart from the production of obnoxious odours the bloom algae contaminate the water and make it unfit for drinking. Livestock compelled to drink water containing bloom algae are reported to have been poisoned. Gillam (*17*) mentions several cases in which livestock partook of water containing these algae with fatal results. Fitch and collaborators (*18*) report poisoning and death of horses, sheep, pigs, turkeys, geese, and cows in Minnesota from drinking water heavily invested with blooms rich in *Microcystis flos-aquae* (Wittr.) Kirchn., *Aphanizomenon flos-aquae* (Linn.) Ralfs, species of *Anabaena*, etc. Prescot (*19*) refers to the death of cattle, sheep, hawks, and fowls within three to six hours after drinking water containing large amounts of blue-green algae. It is believed that toxins are produced by the decomposition of these algae, and even small quantities of toxic water, according to Tilden (*20*), are sufficient to have fatal effects upon laboratory animals, such as rabbits and guinea pigs, both when given *per os* or intraperitoneally.

Associated bacteria

In any study of algae from the toxicological point of view, however, notice must be taken of the products of decomposition by the associated bacteria, since poisoning may be caused by the toxins produced by bacteria rather than the algae; these bacteria find a

convenient harbouring place in the mucilaginous secretions of the blue-green algae. At any rate, the presence of water blooms has been connected with the poisoning of man and livestock, but in spite of their common occurrence in the Indian ponds and tanks supplying water for the consumption of man and animals, no attention has been paid to this problem in this country. Of the possibly harmful algae may be mentioned species of *Anabaena*, *Aphanizomenon*, *Chroococcus*, *Clathrocystis*, *Lyngbya*, *Microcystis*, *Nodularia*, *Nostoc*, *Oscillatoria*, *Pandornia*, *Rivularia*, *Spirulina*, and *Volvox*, when present in sufficient numbers. Prof. Bharadwaja* informs us that water blooms containing several species of these genera commonly occur on the surface of many temple tanks in different parts of India. The harmful effects of blooms on fishes and other aquatic animals also deserve attention. Baldwin and Whipple (*21*) have recorded the death of fishes due to water bloom. They do not think that this is due to any poison, but believe that the death of algae following their blooming causes an exhaustion of the oxygen supply which makes it impossible for the fishes to survive. Rosenberg (*22*) also reports that the decomposition in water of large quantities of vegetable material, following the maximum growth of the *Anabaena* bloom in a Scottish loch near Balloch, was responsible for the death of 640 trout in a single night, and she ascribes this to the absence of oxygen and very high values for ammonia and phosphates. Prescot (*19*) states that at night, when there is no photosynthesis, water containing very heavy growth of algae may have its oxygen drawn upon to such an extent that it falls below the amount necessary to support fish life, and in a still hot night of midsummer a lake may be converted into a graveyard for aquatic organisms.

Harmful algae

Harmful to fishes

Conditions determining appearance of "water bloom"

It is unfortunate that practically no data are available with regard to the limnology of Indian waters. The conditions, which help the blooms in their sudden appearance at one time and disappearance at another in certain waters, and their being perennial or almost perennial in others, are still uninvestigated in India, but are of considerable economic importance. According to Prescot (*19*), high temperature, a large amount of carbon dioxide and nitrogen, and low oxygen content of the water are favourable for the production of blue-green algae; and while alkaline lakes and reservoirs containing large quantities of bicarbonates easily become infested with water blooms, soft-water lakes with low carbon-dioxide content cannot support these forms enough to cause serious troubles.

* We are grateful to Dr. Y. Bharadwaja for the help he has rendered in supplying us with a good deal of the literature in connection with the toxicological aspects of algae.

3.—Control of algal growth

The question of the growth of algae in water reservoirs leads to a very important public health problem. Although in India very little information is available about the contamination of the water supplies with the group of toxic algae, we cannot pass over this important question without drawing attention to the importance of checking their growth in reservoirs of water supply. One of the essentials of algal growth is light. Their growth may, therefore, be prevented, or at any rate considerably reduced, by covering up reservoirs and cutting off sunlight. Unfortunately most of the reservoirs for the supply of water to both animals and man in India are generally not covered and are often largely contaminated with algal growth. The removal of organic matter by keeping the source of water supply in as pure a state as possible will no doubt keep down the algal growth, but it must be understood that nearly all water contains sufficient organic matter for the growth of algae, especially the water coming from watersheds. Growth of algae can also be successfully prevented by the addition of copper sulphate in small amounts. Very weak doses of this poisonous substance are required to kill the algae or prevent their growth; this does not render the water deleterious for man and animals. This salt is also generally employed in eradicating the water blooms. According to Prescot (*19*), 1·6–3·3 pounds of copper sulphate per million gallons of water are sufficient to kill *Microcystis*, *Aphanizomenon*, and *Anabaena*. He mentions the various factors that should be taken into consideration before treating a body of water with this substance, such as the species and number of algae concerned, the amount of water to be treated, its temperature, alkalinity, and the suspended matter. Lesser concentration of the salt is required for killing algae in warm than in cold water. Turbid water requires a slightly greater amount of the salt, and soft water needs smaller dosage than the one which is highly alkaline. According to Haine (*23*), when the algae are killed with copper sulphate, there is a sharp decrease in the oxygen content of the water on account of the bacterial oxidation of the dead algae, and it is this oxygen reduction that may affect the fishes. There is also a general belief that the treatment of tanks and lakes with this substance is fatal to fishes which supply food material for man, but this fear does not seem to be justified. Prescot (*19*) has shown that fishes are not killed when the salt is administered properly; from experiments made in the waters of Iowa lakes, he thinks that fishes can withstand higher concentrations of copper sulphate than are required for algicidal purposes. According to Tiffany (*24*), Langlois and also Wiebe have succeeded considerably in stopping the growth

Sunlight

Organic matter

Algicides

Biological measures

of planktonic algae by stocking fish ponds with young crayfish which keep the water almost constantly turbid, making penetration of light inadequate. Fritsch (25) also advocates the control of algal growth on a biological basis and suggests that undue growth of algae will best be checked by association with an appropriate fauna.

The role of algae in the contamination of fresh-water supplies in India is important and deserves the attention of workers in this field.

XV.—FUNGI

1.—Botanical characters

The fungi constitute a division of Thallophytes comprising the moulds, mildews, rusts, smuts, mushrooms, toadstools, puffballs, and allied forms of which about 40,000 species have so far been described. They are readily distinguished from the algae by the absence of chlorophyll; chromatophores and starch are also wanting. They are nitrogenous in composition. Special characters in their structure, development, and life history provide further distinguishing features. The fungi range in size and form from simple unicellular microscopic cells of the yeast plant to the highly organized fruiting body of mushrooms. The vegetative system consists typically of septate or unseptate filaments called hyphae, which collectively form the mycelium. They reproduce mainly by means of asexual spores which are developed in various ways, often in spore fruits of definite structure. Vegetative and sexual reproduction also occur. The fungi are typically saprophytic or parasitic plants. Some, however, are not confined to one mode of life, but may live as parasites or as saprophytes, according to circumstances. A large number of the diseases of plants are due to the attacks of parasitic fungi.

Distinction from algae

Size and form

Reproduction

Mode of living

2.—Toxicological aspects

The fungi produce deleterious effects in many ways, *viz.* :—

(a) Fungi Living on Skin and Mucous Membranes

Some of the fungi live on the skin and mucous membranes of man and animals, and cause various diseases, *e.g.*, ringworm, thrush, etc.

(b) Fungi Attacking Foodstuffs

There are others which attack foodstuffs and among these may be mentioned : (*a*) Smuts. Many of these are destructive parasites which invade plants of vital economic importance, such as oats, wheat, millet, and other cereals. Some of these are supposed to be poisonous if taken in large quantities, and some are said to produce irritation of the mucous

Smuts

membrane. There is a good deal of disparity of opinion with regard to the injurious effects produced by particular kinds of smuts and hardly any authentic information is available regarding those occurring in India. The subject needs careful investigation by mycologists. (*b*) Rusts. Annual recurrence of the outbreaks of rust attacks of cereals in India, especially those attacking wheat, causes great economic loss to the country. These, especially the "uredo" stage, produce inflammation of the mucous membrane of the mouth and nose. The dust coming from the infested straw, when the grain is threshed, is stated to cause serious disturbances of the respiratory tract. Very little information is available about the Indian strains. (*c*) Ergot (*Claviceps purpurea* Tulasne), which grows on rye, is a well-known example of a fungus which produces highly poisonous substances, but there is no evidence of its occurrence in India. (*d*) The poisonous nature of the seeds of darnel (*Lolium temulentum* Linn.), a grass and annual weed of cultivation, especially in Northern India, is believed to be due to a fungus infection, and cases of poisoning due to admixture of the seeds with wheat grains are not infrequently reported in India and abroad. Deaths among livestock have also been reported. The animals should not be allowed to feed on this plant when seeds are formed. (*e*) Very variable data is available with regard to the poisonous effects of mouldy foodstuffs in India, but there appears to be little doubt that the presence of certain species may occasionally produce harmful effects in man and animals. Species of *Mucor*, *Aspergillus*, *Penicillium*, *Fusarium*, etc., deserve special investigation in this connection. It appears, however, that there is an appreciable difference in the susceptibility of different species of animals to the effects of mouldy foodstuffs. It has been stated that generally speaking horses, dogs, and pigs are more susceptible than ruminants and poultry, while in other animals the case may be the reverse (*5*). Very little information is available about the toxicity of moulds occurring in India and the problem requires thorough investigation because of its great economic importance. In the meantime, it would be safer to consider all fungus-infected foodstuffs as deleterious. Acute poisoning with moulds is rarely met with and if taken in small quantities there is hardly any danger. The practice of throwing away mouldy pickles and other edible substances is no doubt a step in the right direction.

Rusts

Ergot

Darnel

Moulds

(*c*) "*Mushrooms*"

The third group of poisonous fungi belongs to the "mushroom" class. A number of these that are edible, and many occurring in India are indiscriminately eaten. Cases of fungus poisoning,

therefore, are not infrequently met with particularly in the hills. Even cattle are known to have died as a result of eating poisonous mushrooms. Unfortunately very little information is available about the poisonous fungi growing in this country.

Indian poisonous "mushrooms"

Stropharia semiglobata (Batsch) Qúel. from Khasia hills, *Hypholoma fasciculare* (Huds.) Fr. from Darjeeling and Simla, and *Lactarius vellereus* Fr. from Sikkim are regarded as poisonous. There is evidence on record that there exists in Bengal a fungus which closely resembles an edible form but which contains amanitine or muscarine, the poisonous principle of the foreign *Amanita muscaria* Pers. Recently, two varieties of mushrooms were sent to us from Kumaon as poisonous. These were identified as species of *Collybia* and *Cantharellus*. There are probably many more poisonous species than have actually been incriminated as poisons, but on the whole their number may be small, and, indeed, if properly cooked only a few may be dangerous. If washed in water and macerated in vinegar before cooking and if eaten with plenty of bread, there is practically no danger in most cases. But it is safe to avoid mushrooms having a powerful peppery or nauseous taste, and those with a milky juice. Some authors suggest that mushrooms having a volva or a sac, or those with pink spores are dangerous. The safest method, however, is to learn to recognize the edible species and never to eat a fungus until its identity is certain.

Foreign poisonous "mushrooms"

Some of the foreign poisonous fungi, *e.g.*, *Lepiota cristata* Qúel., *Volvaria gloiocephala* Gill., *Amanita muscaria* Pers., and *Amanita phalloides* Fr., are well known. The last-mentioned is responsible for perhaps 90 per cent of the deaths caused by fungus poisoning in Europe, England, and the U. S. A. During the World War, when food scarcity became acute in Germany and Austria, poisoning from fungi appreciably increased.

Types of poisoning

According to Ford (*26*), there are five main types of mushroom intoxication: (*a*) *Gastro-intestinal type.* This is characterized by an early appearance of nausea, vomiting, and diarrhoea. The symptoms terminate rapidly and usually spontaneously, the patient being restored to health in a day or two. It is rarely fatal. (*b*) *Choleriform type.* In this, gastro-intestinal symptoms develop in from ten to fifteen hours, followed by rapid loss of strength and weight. The mortality in this type is high. (*c*) *Nerve-affecting type.* Here gastro-intestinal symptoms appear in two or three hours after the fungus has been eaten and terminate in violent convulsions, delirium, coma, and often in death. The active poisonous principle is muscarine for which atropine is an excellent antidote. (*d*) *Blood-dissolving type.* This is characterized by abdominal distress, with jaundice developing in four or five days. Death may result. Blood transfusion is suggested by Ford in the treatment of

such cases. (*e*) *Cerebral type.* Here the symptoms that appear are of a transient nature and consist of exhilaration, staggering gait, and extraordinary disturbances of vision. The patients soon become normal.

XVI.—LICHENS

1.—Botanical characters

Habitat

The lichens are a group of thallophytic plants growing as epiphytes on various plants, especially on their barks, and on rocks, stones and other places. They generally present a peculiar withered appearance and are extremely xerophytic plants, many species growing on the barest and driest of rocks where few other plants can maintain themselves. They have a flat or branching thallus, not differentiated into stem and leaf, but varying greatly in texture, being foliaceous, cartilaginous, crustaceous, fruticose or gelatinous. A lichen is a composite organism, consisting of a fungus living symbiotically with an alga. The algal cells, called gonidia, are enveloped by the mycelium of the fungus and supply food material to it, while the fungus in return protects the alga from exposure or injury.

Habit

Mode of living

2.—Uses

Some lichens are used as food or fodder in foreign countries, such as the reindeer moss (*Cladonia* sp.) and iceland moss [*Cetraria islandica* (Linn.) Ach.]; a decoction of the latter is also used in medicine as a demulcent. Others, *e.g.*, *Roccella* sp., furnish dyestuffs, such as litmus and archil.

3.—Toxicological aspects

Very little is known about the toxicological aspects of lichens. Although this group is not regarded as a serious menace to livestock, yet cases of poisoning due to species of *Parmelia* and *Cetraria* and others are mentioned in foreign literature. *Parmelia molliuscula* has been said to affect sheep and cattle, producing lack of co-ordination of movements of the hind limbs. In more severe cases, the animal lies down and is unable to move either its front or hind limbs. Little or no information is available about lichens occurring in India and even their systematics have not been sufficiently worked out.

XVII.—BRYOPHYTA

1.—Botanical characters

The Bryophyta form the second important group of Cryptogams and include the liverworts (Hepaticae) and the mosses (Musci). They

are characterized by the presence of archegonia (the female sexual organs containing the egg or ovum) of a complex structure and by a certain degree of differentiation into leaf and stem. In the simplest case the plant is a thalloid gametophyte, *i.e.*, the vegetative body is not differentiated into stem and leaf and bears the sexual organs producing gametes, as in many liverworts; in the highest forms the gametophyte is a leafy shoot, as in some liverworts and all mosses. True roots are never present in the Bryophytes, but a number of unicellular root-hairs or multicellular filaments anchor them to the soil. There is a distinct alternation of generations, *i.e.*, the fusion of the male and female gametes leads to the formation of a zygote which does not at once produce the gametophyte; on the other hand, it produces a structure, known as the sporogonium, which produces the asexual spores. The asexual spore, on liberation from the sporogonium and on germination, produces a confervoid or plate-like growth, known as protonema, from which the gametophyte is again developed. In the Bryophytes, therefore, the sexual and asexual or sexless generations regularly alternate, *i.e.*, the gametophyte gives rise to the sporophyte and the sporophyte to the gametophyte. In the Thallophytes, this alternation of generations is rather feeble or not at all defined. In other groups, *i.e.*, the Pteridophytes and the Phanerogams it is found, but with the difference that, whereas in Bryophytes the plant body is a gametophyte, and the sporophyte stage is comparatively an inconspicuous feature, in the other groups it is the sporophyte that is the dominant phase of the life history. Vegetative reproduction is also met with in this group. A characteristic feature of the Bryophytes is that they can be thoroughly dried, so much so that they can be powdered at this stage, but on being immersed in water, or on approach of moisture, they revive even without loss of colour. This property is very helpful in tiding over unfavourable conditions, such as drought. This group shows many features of structure linking it with the Pteridophyta on the one hand and with the Thallophyta on the other.

Form

Alternation of generations

Vegetative reproduction

Drought-resisting property

Relationships

Liverworts and mosses distinguished

Liverworts are distinguished from mosses by their thalloid gametophyte and unicellular rhizoids and elaters (spirally twisted hygroscopic filaments occurring among the spores and helping in their dispersal). Several liverworts, however, have a leafy gametophyte with the leaves arranged on the stem in two or three rows, *viz.*, two on the upper and, in most cases, one on the underside, but there is no midrib. The protonema in the liverworts is only slightly developed. Mosses, on the other hand, are characterized by the small leafy, often tufted stems bearing sex organs at their tips, and generally by the presence of multicellular and branched rhizoids. The leaves in mosses are

arranged all round the stem as opposed to the dorsiventral arrangement in the leafy liverworts, and usually have a midrib ; very rarely, however, the leaves are in two rows as in *Fissidens*, but the midrib is even then present. The protonema in mosses is well developed and resembles a branched filamentous alga. Elaters are never found in mosses, but there is almost always present in the sporogonium a central mass of sterile cells, the columella. Liverworts are chiefly moisture-loving plants and are found in damp and shady places ; a few are also found floating in fresh water. Mosses are found in varied situations, on earth, rock, bare stones, the bark and sometimes even on the leaves of trees, rarely in streams, etc. ; a number of them are capable of living under most xerophytic conditions.

2.—Toxicological aspects

The Bryophytes constitute the least known group of plants from the point of view of poisoning and we have nothing to add about them.

XVIII.—PTERIDOPHYTA

1.—Botanical characters

The Pteridophytes, often referred to as the Vascular Cryptogams, form the third great group of the cryptogamic flora and include the ferns, the horsetails, and the club-mosses. They represent the highest type of "flowerless plants," having well-developed vascular and tegumentary systems, and exhibiting a complete differentiation into root, stem, and leaf. The stem, which sometimes attains a considerable size, may be either subaerial or a rhizome. The leaves are very varied ; in the ferns they are large and compound (fronds) ; in the club-mosses they are numerous though small in size ; in the horsetails they are scaly.

Form

Alternation of generations

As in the Bryophytes, there are two distinct phases in the life cycle of plants belonging to this group. Unlike the Bryophytes, however, but like the Phanerogams, the sporophyte or the asexual generation is the conspicuous generation (it is the fern, horsetail, club-moss, etc., as popularly known) which shows a considerable degree of morphological and anatomical differentiation. In the Bryophyta, the asexual generation is the sporogonium which is limited in its development and is dependent, to a large extent, upon the sexual generation on which it is situated, but in the Pteridophyta this generation is a highly developed plant leading an independent existence. It bears spores inside the "sporangia" situated on the back of or on the margin or at the base of leaves or of modified leaves (sporophylls). The spores

may be all similar (homosporous) or they may be of two kinds (heterosporous)—macrospores (or megaspores) and microspores; the former produce only female prothallia (*i.e.*, the prothallia bearing archegonia only) and the latter produce male prothallia (*i.e.*, the prothallia bearing antheridia only). Unlike the Phanerogams, the Pteridophytes produce no seeds. The gametophyte, or the sexual generation bearing archegonia and antheridia, in Vascular Cryptogams is reduced to a small thalloid body, the prothallium. The ferns (Filicales) form the most important and largest group of Pteridophytes comprising as they do about 4,000 species at the present day. They are shade-loving plants, and although they are also found in temperate regions, they are especially abundant in shady tropical forests. In a majority of ferns the stem consists only of a subterranean rootstock, but some have erect woody trunks and are known as tree ferns. The other two groups of Vascular Cryptogams, *i.e.*, the club-mosses (Lycopodiales) and horsetails (Equisetales), were well represented by many plants in early geological periods, but have only a few representatives at the present time. Except for a very few tree ferns, practically all Pteridophytes are herbaceous.

Ferns

Club-mosses and horsetails

2.—Toxicological aspects

Little or no work has been done in India with regard to the toxicology of Pteridophytes. Even in foreign countries this group is not well investigated. References to the supposed or actual toxic properties of some of the Vascular Cryptogams, however, are occasionally found in literature. According to Pammel (*16*), Greshoff and others have reported the presence of hydrocyanic acid in a number of ferns, especially when young. He also states that several species of *Gleichenia* contain saponins. Several species of *Aspidium*, *Dryopteris*, *Pteridium*, *Adiantum*, *Davallia*, *Osmunda*, *Equisetum*, etc., are known or suspected to be poisonous in foreign countries, but practically nothing is known about the Indian representatives of these genera. It is proposed here briefly to discuss the toxicological aspects of those ferns and their allies which are of importance to India and regarding which information is available.

FERNS

Pteridium aquilinum

References to the poisonous properties of the bracken [*Pteridium aquilinum* (Linn.) Kuhn, syn. *Pteris aquilina* Linn.] have appeared in foreign literature for a long time; this fern is also found in India. It has been stated that the fern is not ordinarily eaten by livestock unless they are forced to do so owing to the scarcity of normal fodder.

Furthermore, it has been experimentally shown that large quantities of the plant must be taken over a prolonged period to produce poisoning in animals. Moderate quantities of the fern, when taken along with other foodstuffs, have been stated to be harmless. The poisonous principle responsible for the deleterious effects of this fern is still unknown. It has been referred to by various authors as filicin, pteritannic acid which is identical with filicic acid, or the one similar to the toxic principle of soya meal. Recent experimental evidence points to the fact that the toxic principle of bracken may act as a photosensitizing agent when eaten by cattle (*5*, *27*, *28*).

Dryopteris filix-mas

The male fern [*Dryopteris filix-mas* (Linn.) Schott, syn. *Aspidium filix-mas* (Linn.) Sw.], a foreign plant, is suspected of being poisonous. Its rhizomes, which are used in Western medicine in the treatment of tapeworm, hookworm, and liver fluke, are imported into India. The active constituents of the male fern are a number of nonnitrogenous acids, the most important among them being filicic acid (filicin). The amorphous filmaron is perhaps an impure filicic acid, or as is considered by some the parent substance from the decomposition of which all the other substances are formed. Filicic acid bodies are toxic substances, their chief action in mammals being on the gastro-intestinal tract and on the central nervous system. Symptoms of poisoning may occur even with moderate doses, while larger doses are dangerous. Death has occurred, especially if large doses (more than 2 drachms of liquid extract) are employed. In mild cases headache, vertigo, and increased reflex activity are the symptoms of poisoning by these substances. In moderately severe cases, there is marked gastro-enteritis, shortness of breath, and sometimes amblyopia. In severe cases, the central nervous system is affected, with delirium, violent muscle-cramps, syncope, tonic convulsions, and coma. Death occurs by respiratory paralysis. Recovery is slow, and when it takes place, there is impairment of sight in one or both eyes which is usually permanent (*29*).

HORSETAILS

Some of the foreign species of *Equisetum* (horsetails) have long been recognized as injurious to cattle and horses. They produce an intoxication during which animals stagger about and wander aimlessly. There is no information available in India with regard to the Indian horsetail, *Equisetum arvense* Linn., but several European and American workers are convinced that it is definitely poisonous to horses, while others hold a contrary opinion. This plant grows commonly in certain places in India where it might be a menace to livestock.

XIX.—PHANEROGAMS

The Phanerogams (flowering plants) include the most highly organized plants which are, in general, characterized by a marked development of the sporophyte or the asexual generation, with great differentiation of its parts (roots, stems, leaves, etc.), by the extreme reduction of the gametophyte or the sexual generation, and by the development of seeds. The alternation of sexual and asexual generations of which some indications are found in certain Thallophytes has been shown to be very prominent in the Bryophytes and the Pteridophytes, both of which constitute the higher Cryptogams. It is also found in the Phanerogams but not in such a pronounced degree; it is concealed in the formation of the ovule and the seed. The sexual generation which is the dominant phase of the life cycle of the Bryophytes, and is dominated by the asexual generation in the Pteridophytes, but mostly still capable of an independent existence, is so far reduced in the Phanerogams that it has almost given up its independence. On the other hand, the asexual generation which is less dominant in the Bryophytes, takes the dominant position in the Pteridophytes and the Phanerogams, and constitutes the plant as popularly understood. The seed in the case of Phanerogams represents two alternate or three successive generations: (*a*) the parent sporophyte, *viz.*, the integuments of the ovule forming the testa or seed coat, (*b*) the new sporophyte in embryo, and (*c*) the female gametophyte or the endosperm (unless this has been consumed by the growing embryo). The endosperm (albumen) is the nutritive tissue contained in the seeds of many plants for the purpose of nourishing the embryo during germination. The seeds containing this are termed albuminous (endospermous) in distinction to the exalbuminous seeds or those in which the nutritive tissue is stored in the embryo itself, before it is completely developed, and used for its sustenance. The presence of a seed is an extremely important character of the Phanerogams, and one which sharply distinguishes it from the Cryptogams in which this structure is not met with. It may be mentioned that the phrase "flowering plants" is less distinctive and does not adequately define the phanerogamic group, since oaks, conifers, grasses, etc., do not produce flowers in the popular sense. For this reason, many botanists prefer the name Spermatophyta (seed plants) to Phanerogamia for this group; but the term Phanerogamia has the authority of long usage.

Varying in size from the minutest dicotyledonous plant *Arceuthobium minutissimum* Hook. *f.*, and some representatives of the aquatic Lemnaceae belonging to the Monocotyledons, to majestic trees and huge

climbers of the evergreen forests, the Phanerogams form the most numerous group, including over 126,000 species. They are economically the most important for man and animals from the point of view of everyday necessities of life, *e.g.*, food, medicines, timber, fibre, etc. It is probably on account of this that much more information is available with regard to the toxicological aspects of this group than in the case of the Cryptogams. It must, however, be admitted that even in this group vast gaps still exist; this is particularly the case with the Indian flora in connection with the toxicological aspects of which no comprehensive studies have been undertaken. Botanically, the Phanerogams have been classified into smaller groups known as classes, series, orders, families, genera, etc. In the following pages of this introduction, we deal briefly with all groups higher than the families, while the detailed botanical and toxicological aspects of the families, genera, and species are discussed in the main text.

CLASSIFICATION

Object of classification

Several systems of classification of plants have been proposed and are still being proposed. With the theory of Organic Evolution having been universally accepted by scientists, the aim and object of classification is not simply to group together those plants which resemble one another in some one prominent character, and on this basis to name and describe the plants. The object of classification on the other hand is not only to facilitate the determination of plants, but also to take into consideration all possible characters and to arrange them so as to indicate, as far as possible, their probable line of descent. In other words, botanists are striving to evolve a natural system of classification, which may be true phylogenetically and give an insight into the sequence of evolution in the vegetable kingdom. The history of various classifications of the vegetable kingdom so far proposed shows how in the original attempts some single superficial morphological character was valued for artificially grouping and naming plants. Later, with the development of the botanical science it was realized that a study of several characters was necessary for grouping, arranging, and naming of the plants, so that relationships between them could be properly understood. But so far morphology has been the basis of classification. It must, however, be admitted that morphology is not the sole weapon now at the disposal of scientists with which to unravel the mysteries of plant life for understanding the course of evolution. During the course of evolution, the chemical constituents and physiological properties of plants have also undergone

Ideal classification

changes side by side with the evolution of morphological characters. The more the characters exhibited by plants, therefore, are taken into consideration the greater are the chances of arriving at a perfectly natural classification. This aspect of the question has been discussed by Chopra (*30*), who says : " With the advance of knowledge of the chemistry and pharmacology of plants, it appears to be certain that some correlation exists between the botanical classification of plants, their chemical constitution and physiological properties, and one is frequently struck with the remarkable resemblance exhibited by closely allied plants in this respect. For example, if a particular chemical constituent is found in one member of the genus, there is considerable likelihood of the presence of constituents with identical or similar physiological properties in other members of the genus or of the family. This does not, of course, mean that such similarity will not be found in other families or genera just as particular taxonomic characters may be spread over widely different families and genera. An ideal classification of plants would be the one which in addition to satisfying botanical criteria broadly provides an index to the nature of their chemical constituents and physiological properties. With our existing knowledge this is not possible. The very fact that some of the families and genera, as at present understood, are quite homogeneous in these respects, however, reflects a ray of hope that after all the problem is not so difficult as it appears at first sight. Considerable work on the chemistry of plants and the determination of the physiological properties of their active principles, however, will have to be carried out and thousands of new plants will have to be investigated before this is attained, or the attempt given up as hopeless. This should not, however, be understood to imply that I suggest that advances in the knowledge of chemistry and pharmacology should determine the botanical classification of plants. This is not possible, as such features cannot possibly serve as taxonomic characters. But I do hope that botanists, chemists and pharmacologists will collaborate in evolving a natural system of classification based on their combined efforts." Chopra refers to many chemical constituents and physiological properties of the Indian Phanerogams and points out similarities in allied genera, families, etc. ; he also traces similarities in remotely different groups. In this way he shows that marked resemblances between the botanical, chemical, and pharmacological aspects exhibited by certain groups, as understood at present, " provide sufficient evidence in support of the now well-established theory of organic evolution. I repeat that there is a method in their occurrence ; in several cases it is due to their descent from common ancestors while in others it is a result of parallel evolution.

The facts described above cannot be explained on any other basis". He continues: "Many more examples could be cited, but the brief review of the relationship which seems to exist between the botanical classification and the chemical and physiological characteristics of medicinal and poisonous plants should prove sufficient to show that in many of the families and genera these characteristics show a marked degree of correlation. I do hope that further work will produce increasing evidence of this relationship. The botanical characters, chemical constituents and properties exhibited by plants are all the results of organic evolution and a natural classification must embrace all these three aspects. There is, however, an element of disturbance in the case of plants. Climate, seasons, soil, cultivation, etc., have profoundly affected their chemical composition and hence their physiological characteristics, and it is for this reason also that closely related plants differ in their pharmacological properties."

Present classifications

There is no really natural classification of Chopra's conception available, nor is there likelihood of any such being formulated in the near future. But whatever may be the faults of the systems of classification of plants in vogue at present, they are excellent stepping-stones for the desired ideal. Of the important systems of classification so far proposed, mention may be made of the Bentham and Hooker's System set forth by George Bentham and Joseph Dalton Hooker for the classification of flowering plants, in their monumental "Genera Plantarum" (1862–83); and Engler's System propounded by Adolph Engler in his great work "Syllabus der Pflanzenfamilien" (1892), followed later in "Die natürlichen Pflanzenfamilien" of which he was the chief editor. These are the two systems most in vogue at the present day. Hutchinson's System which deals with the Angiosperms only is, perhaps, more in conformity with the evolutionary course than others. For reasons set forth in the preface, however, we have thought it best to follow Bentham and Hooker's System in this work. The larger groups and subgroups, according to this system, are given in a tabular form below to indicate the general plan of classification. The orders are further divided into families, and wherever the higher groups have not been divided into orders in the following plan, they are directly divided into families in this system. It may be mentioned that the term "Cohort" used by the authors of this system has been replaced here by the term "Order", likewise, the term "Natural Order" has been replaced by the term "Family" with the termination of *aceae* except where the original spellings are conserved according to the International Rules.

Bentham and Hooker's System

VEGETABLE KINGDOM

- Division I Cryptogamia
- Division II Phanerogamia
  - Subdivision 1 Angiospermia
    - Class 1 Dicotyledons
      - Subclass 1 Polypetalae
        - Series 1. Thalamiflorae
          - Order 1. Ranales
          - ,, 2. Parietales
          - ,, 3. Polygalinae
          - ,, 4. Caryophyllinae
          - ,, 5. Guttiferales
          - ,, 6. Malvales
        - Series 2. Disciflorae
          - Order 7. Geraniales
          - ,, 8. Olacales
          - ,, 9. Celastrales
          - ,, 10. Sapindales
          - Anomalous families
        - Series 3. Calyciflorae
          - Order 11. Rosales
          - ,, 12. Myrtales
          - ,, 13. Passiflorales
          - ,, 14. Ficoidales
          - ,, 15. Umbellales
      - Subclass 2 Gamopetalae
        - Series 1. Inferae
          - Order 1. Rubiales
          - ,, 2. Asterales
          - ,, 3. Campanales
        - Series 2. Heteromerae
          - Order 4. Ericales
          - ,, 5. Primulales
          - ,, 6. Ebenales
        - Series 3. Bicarpellatae
          - Order 7. Gentianales
          - ,, 8. Polemoniales
          - ,, 9. Personales
          - ,, 10. Lamiales
          - Anomalous family
      - Subclass 3 Monochlamydeae
        - Series 1. Curvembryae
        - ,, 2. Multiovulatae Aquaticae
        - ,, 3. Multiovulatae Terrestres
        - ,, 4. Micrembryae
        - ,, 5. Daphnales
        - ,, 6. Achlamydosporeae
        - ,, 7. Unisexuales
        - Anomalous families
    - Class 2 Monocotyledons
      - Series 1. Microspermae
      - ,, 2. Epigynae
      - ,, 3. Coronarieae
      - ,, 4. Calycinae
      - ,, 5. Nudiflorae
      - ,, 6. Apocarpae
      - ,, 7. Glumaceae
  - Subdivision 2 Gymnospermia
    - Class 1 Cycadeae
    - Class 2 Coniferae
    - Class 3 Gneteae

SYNOPSIS OF ORDERS

We give below the botanical characters of various groups of Phanerogams, up to orders. This synopsis is intended to serve as a guide to the families of poisonous plants which are dealt with in detail later on. A few of the more important exceptional characters are also given. The number of families belonging to each order, and their occurrence in India, are indicated. The families containing Indian plants which are known or suspected to be poisonous are specially listed; others do not contain poisonous Indian representatives and, therefore, do not come under the scope of this monograph. Some of the recently published Indian provincial and local floras, although following the arrangement of Bentham and Hooker, deal with some of the families as understood by Engler and Prantl. For the convenience of Indian readers who may happen to consult these floras, as also for the benefit of those overseas readers who exclusively follow the System of Engler, it has been thought desirable broadly to distinguish the families as limited by the propounders of these systems. When, therefore, the family as defined by Bentham and Hooker, for which the abbreviation *B. H.* has been used, differs from that as defined by Engler and Prantl (which is abbreviated as *E. P.*), the difference has been indicated within a bracket immediately following the name of the poisonous family as understood by Bentham and Hooker.

I. Dicotyledons

Trees, shrubs or herbs. Stem, when perennial, with pith surrounded by concentric layers of wood and a separable bark, increasing in girth by the addition of exogenous layers of wood and endogenous layers of bark. Leaves with reticulate venation, petioled or sessile, but rarely having a long sheathing base as is so common in Monocotyledons. Whorls of perianth tetramerous or pentamerous, usually not trimerous. Ovules enclosed in an entirely closed chamber (ovary), in which they mature and ripen into seeds. Embryo with 2 seed-leaves or cotyledons; radicle on germination elongating to form the primary root.

Exceptions.—The sheath at the base of leaves is well developed in Umbelliferae. Trimerous flowers are found in Annonaceae, Menispermaceae, Berberidaceae, and in a few other families. Cotyledons are not developed in *Cuscuta* (Convolvulaceae).

1. Polypetalae.—Flowers usually with two whorls of perianth, *i.e.*, with both calyx and corolla. Petals free.

Exceptions.—Flowers in which either calyx or corolla is absent occur in the families Ranunculaceae, Menispermaceae, Cruciferae, Bixaceae,

Caryophyllaceae, Rutaceae, Rhamnaceae, Sapindaceae, Anacardiaceae, Combretaceae, Lythraceae, Samydaceae, Aizoaceae (Ficoidaceae), etc. Flowers with petals more or less connate at base occur in the families Annonaceae, Menispermaceae, Ternstroemiaceae, Malvaceae, Crassulaceae, Myrtaceae, Cucurbitaceae, etc.

Series 1. Thalamiflorae.—Flowers mostly regular and 2-sexual. Sepals usually distinct and separate, inferior. Petals uniseriate or often 2–many-seriate, distinct or united at the very base only, hypogynous. Stamens numerous or definite, hypogynous, rarely inserted on a short or long torus, or on a disc. Ovary superior (syncarpous or apocarpous).

Order 1. Ranales.—Stamens numerous, rarely definite and then the perianth 3–many-seriate. Carpels free or immersed in the torus, very rarely united. Micropyle usually inferior. Embryo minute, in fleshy albumen.

This order comprises 8 families of which 7 are represented in India, but only 5 contain poisonous plants. These are: Ranunculaceae, Magnoliaceae (=Magnoliaceae and Trochodendraceae of *E. P.*), Annonaceae (=Annonaceae and Eupomatiaceae of *E. P.*), Menispermaceae, and Berberidaceae (=Berberidaceae and Lardizabalaceae of *E. P.*).

Order 2. Parietales.—Stamens numerous or definite. Carpels united into a unilocular ovary with parietal placentas, rarely 2- or more-celled by spurious dissepiments. Albumen absent or fleshy.

There are 9 families in this order, of which 6 are represented in India. Of these only 4 contain poisonous plants; they are: Papaveraceae*, Cruciferae, Capparidaceae, and Bixaceae (=Bixaceae, Flacourtiaceae, and Cochlospermaceae of *E. P.*).

Order 3. Polygalinae.—Herbs or shrubs with exstipulate leaves. Sepals and petals 5, rarely 4 or 3. Stamens definite, as many or twice as many as petals. Ovary 2-, rarely 1- or more-locular. Fruit very often compressed laterally. Albumen very often abundant and fleshy, rarely absent.

This order comprises 4 families, 2 of which are represented in India. Only one of these, *viz.*, Polygalaceae, contains poisonous plants.

Order 4. Caryophyllinae.—Flowers regular. Divisions of calyx 2–5, rarely 6. Petals usually as many. Stamens as many or twice as many, rarely more or fewer. Ovary unilocular or imperfectly 2–5-celled;

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* Following Fl. Brit. Ind., Papaveraceae in this work has been split up into two families, Papaveraceae and Fumariaceae.

placenta free-central, rarely parietal. Embryo curved, rarely straight; albumen farinaceous.

This order contains 4 families all of which are represented in India, but only Caryophyllaceae (*E. P.* include Illecebraceae of *B. H.* also under this) contains poisonous representatives.

Order 5. Guttiferales.—Flowers regular. Divisions of calyx and corolla usually 4–5, imbricate. Stamens usually numerous. Ovary 3–many-celled, rarely 2-locular or of 1 carpel; placentas on inner angles of loculi. Albumen absent or fleshy.

This order comprises 6 families of which 5 are represented in India, but only 3 contain poisonous plants. These are: Hypericaceae (part of Guttiferae in *E. P.*), Guttiferae (=Guttiferae, in part, and Quiinaceae of *E. P.*; *see* Hypericaceae), and Ternstroemiaceae (divided into several families by Engler; the bulk of the genera are placed in Theaceae and the rest are dispersed in Caryocaraceae, Marcgraviaceae, Stachyuraceae, Dilleniaceae, Guttiferae, etc.).

Order 6. Malvales.—Flowers usually regular. Sepals 5, rarely 2–4, free or united, valvate or imbricate. Petals as many as sepals or 0. Stamens usually numerous or monadelphous. Ovary 3–many-celled, rarely of 1 carpel; placentas on the inner angles of the loculi. Albumen absent or fleshy.

This order consists of 3 families all of which are represented in India, but only Malvaceae (=Malvaceae and Bombacaceae of *E. P.*) contains poisonous representatives.

Series II. Disciflorae.—Sepals distinct or united, inferior or rarely superior to ovary. Petals uniseriate, distinct or connate at the very base. Torus generally expanded into a pulvinate or cupular disc between the petals and ovary, rarely of glands or 0. Stamens usually definite, inserted upon or at the outer or inner base of the disc. Ovary superior or immersed in the disc.

Exceptions.—Disc lining the calyx in Rhamnaceae and Anacardiaceae; not present in *Coriaria* and in some Linaceae and Geraniaceae. Petals in *Coriaria* become fleshy and enclose the ripe carpels.

Order 7. Geraniales.—Flowers often irregular. Disc usually annulate, adnate to the stamens or reduced to glands alternating with the petals, more rarely absent. Ovary of several carpels, syncarpous or subapocarpous. Ovules 1–2 in each cell, rarely numerous, ascending or pendulous; raphe usually ventral.

This order comprises 11 families of which 10 are represented in India. Of these, only the following 5 contain poisonous representatives;

Linaceae (=Linaceae and Erythroxylaceae of *E. P.*), Zygophyllaceae, Rutaceae (=Rutaceae of *E. P.*, except that a couple of its genera are placed in Meliaceae by *B. H.*), Simaroubaceae (=Simaroubaceae, Brunelliaceae, Cneoraceae, and Koeberliniaceae of *E. P.*), and Meliaceae (=Meliaceae of *E. P.*, except a couple of genera which are placed in Rutaceae, are included here by *B. H.*).

Order 8. Olacales.—Shrubs or trees. Leaves alternate, simple, exstipulate. Flowers regular, bisexual or unisexual. Calyx small. Disc free, cupular or annular, rarely glandular or 0. Ovary entire, 1–many-celled. Ovules 1–3 in each loculus, pendulous ; raphe dorsal, integument confluent with the nucellus. Albumen usually copious, fleshy ; embryo small.

This order comprises 3 families, 2 of which are represented in India, but neither of these contains any poisonous representative in this country.

Order 9. Celastrales.—Leaves simple except in Ampelidaceae. Flowers regular, bisexual. Corolla hypogynous or perigynous. Disc tumid, adnate to the base of calyx-tube or lining it. Stamens as many as petals or fewer, rarely twice as many, perigynous or inserted outside the disc or on its margin. Ovary generally entire. Ovules 1–2 in each cell, erect with ventral raphe.

This order contains 4 families of which 3 are represented in India. All these, *viz.*, Celastraceae, Rhamnaceae, and Ampelidaceae (=Vitaceae of *E. P.*), have poisonous representatives in India.

Order 10. Sapindales.—Shrubs or trees. Leaves pinnate, or more rarely simple or digitate. Flowers often irregular and unisexual. Disc tumid, adnate to the base of calyx or lining its tube. Stamens perigynous or inserted upon the disc or between it and the ovary, usually definite. Ovary entire, or more often lobed or subapocarpous. Ovules more often 1–2 in each cell, usually ascending with a ventral raphe, or reversed, or solitary and pendulous from an ascending funicle, or rarely numerous horizontal. Seed usually exalbuminous ; embryo often curved or crumpled.

This order comprises 3 families all of which are represented in India. Two of these, *viz.*, Sapindaceae (=Sapindaceae, Aceraceae, Hippocastanaceae, Melianthaceae, and Staphyleaceae of *E. P.*) and Anacardiaceae (=Anacardiaceae, Corynocarpaceae, and Julianiaceae of *E. P.*), contain poisonous plants.

Anomalous families or rather genera.—Under this are included 2 families both of which are represented in India and contain poisonous plants. These are Coriariaceae and Moringaceae.

Series III. Calyciflorae.—Flowers regular or irregular, 1- or 2-sexual. Calyx of united rarely free sepals, its tube more or less investing or adnate to the ovary. Petals uniseriate, distinct or united at the base, inserted on the calyx-tube. Stamens many or definite, inserted on the calyx-tube, or most often on the disc lining the calyx-tube. Ovary often included in the calyx-tube, or inferior (syncarpous or apocarpous).

Exceptions.—Stamens epipetalous in *Kalanchoe* (Crassulaceae).

Order 11. Rosales.—Flowers usually bisexual, regular or irregular. Carpels 1 or more, usually quite free in bud, sometimes variously united afterwards with the calyx-tube or enclosed in the swollen top of the peduncle ; styles distinct, or very rarely united into a column, and easily separated.

This order comprises 9 families of which 8 are represented in India. Of these, 4 contain poisonous Indian representatives, *viz.*, Leguminosae*, Rosaceae (=Rosaceae and Eucryphiaceae of *E. P.*), Crassulaceae, and Droseraceae.

Order 12. Myrtales.—Leaves simple, usually quite entire, rarely 3-foliolate in Combretaceae. Flowers regular or subregular, usually bisexual. Ovary syncarpous, usually inferior, or enclosed in the calyx-tube, generally divided into cells ; style undivided, or very rarely styles free ; placentas axile or apical, rarely basal. Ovules 2–many in the loculi.

This order consists of 6 families all of which are found in India, but only 3 of these contain poisonous representatives. These are : Combretaceae, Myrtaceae (=Myrtaceae and Lecythidaceae of *E. P.*), and Lythraceae (=Lythraceae, Oliniaceae, Punicaceae, and Sonneratiaceae of *E. P.*).

Order 13. Passiflorales.—Flowers usually regular, bisexual or unisexual. Ovary usually inferior, syncarpous, unilocular with parietal placentation, sometimes 3- or more-celled by the produced placentas ; styles free or connate.

This order comprises 7 families of which 5 are represented in India. Of these, Samydaceae (included in Flacourtiaceae by *E. P.* ; *see* Bixaceae), Passifloraceae† (=Passifloraceae, Achariaceae, Caricaceae, and Malesherbiaceae of *E. P.*), Cucurbitaceae, and Begoniaceae contain poisonous representatives.

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* The family Leguminosae of *B. H.* and *E. P.* has been rightly split up into three families by some modern authors, *viz.*, into Papilionaceae, Caesalpiniaceae, and Mimosaceae.

† The Indian poisonous representatives of Passifloraceae of Bentham and Hooker are dealt with under the families Passifloraceae and Caricaceae in the text.

Order 14. Ficoidales.—Flowers regular or subregular. Ovary syncarpous, inferior or superior, unilocular with parietal, or 2–many-celled with axile or basal placentas; styles distinct, or divided at the apex. Embryo curved, with albumen, or rolled up circularly, or oblique with no albumen.

This order comprises 2 families both of which are represented in India, but only Ficoidaceae (=Aizoaceae of *E. P.*) contains poisonous plants.

Order 15. Umbellales.—Flowers regular, usually bisexual. Stamens usually definite. Ovary inferior, crowned by the disc, 1–2–many-celled: ovules solitary and pendulous in each loculus from its apex; styles distinct or united at the base. Seeds with albumen; embryo usually minute.

Of the 3 families of this order, all of which are represented in India, only 2, *viz.*, Umbelliferae and Araliaceae, contain poisonous representatives.

2. Gamopetalae.—Leaves usually simple. Flowers usually 2-sexual, regular or irregular. Sepals usually united to form a superior or inferior calyx, often persistent. Petals connate, forming an entire or cleft corolla, rarely free to a little above the base. Stamens inserted on the corolla, rarely hypogynous or epigynous. Pistil never apocarpous, or if carpels distinct, then styles united and carpels only 2.

Exceptions.—Limb of calyx obsolete in some Rubiaceae, and in many representatives of Compositae; sepals nearly free in some Sapotaceae, Apocynaceae, Asclepiadaceae, and Convolvulaceae. Flowers with free petals are found in Campanulaceae, Myrsinaceae, Ebenaceae, etc.; corolla absent in the female flowers of *Xanthium*. Free and hypogynous stamens are found in *Plumbago*. In Asclepiadaceae the pollen adheres in masses (pollinia).

SERIES I. INFERAE.—Ovary inferior. Stamens usually as many as the lobes of the corolla, rarely fewer.

Order 1. Rubiales.—Flowers regular or irregular. Stamens epipetalous. Ovary 2–many-celled, cells 1–many-ovuled.

The two families included in this order, *viz.*, Caprifoliaceae (=Caprifoliaceae and Adoxaceae of *E. P.*) and Rubiaceae, are both represented in India and contain poisonous plants.

Order 2. Asterales.—Flowers regular or irregular. Stamens epipetalous. Ovary 1-celled, 1-ovuled, sometimes more than 1-celled, but with only 1 ovule.

This order includes four families all of which are represented in India. Of these, only the Compositae contains poisonous representatives.

Order 3. Campanales.—Flowers usually irregular. Stamens generally epigynous. Ovary 2–6-celled, with usually many ovules in each loculus.

All the three families belonging to this order are represented in India, but of these only the Campanulaceae contains poisonous plants.

SERIES II. HETEROMERAE.—Ovary generally superior. Stamens epipetalous or free from the corolla, opposite or alternate to its lobes, or twice as many, or numerous. Carpels more than 2.

Order 4. Ericales.—Corolla usually regular and hypogynous. Stamens as many as and alternating with the lobes of the corolla, or double their number. Ovary 1–many-celled, with 1-many ovules in each loculus. Seeds small, frequently minute.

This order comprises 6 families of which 5 are represented in India. Of these, only Ericaceae (=Ericaceae in part, Pyrolaceae in part, and Clethraceae of *E. P.*; the Vaccinioideae, dealt with under Ericaceae by *E. P.*, is the family Vacciniaceae of *B. H.*) contains poisonous plants.

Order 5. Primulales.—Corolla usually regular and hypogynous. Stamens generally as many and opposite to the lobes of the corolla. Ovary unilocular, with a free-central or basal placenta and 1–many ovules.

This order comprises 3 families all of which are represented in India and contain poisonous plants. These are : Plumbaginaceae, Primulaceae, and Myrsinaceae (=Myrsinaceae and Theophrastaceae of *E. P.*).

Order 6. Ebenales.—Trees or shrubs. Corolla generally hypogynous. Stamens usually more than the lobes of the corolla, or if as many, then opposite to them, except in Sapotaceae, often numerous. Ovary 2–many-celled ; ovules usually few. Seeds few and large.

This order consists of 3 families all of which are represented in India. Only 2 of them, *viz.*, Sapotaceae and Ebenaceae, however, contain poisonous plants.

SERIES III. BICARPELLATAE.—Ovary generally superior. Stamens equal in number or fewer than the lobes of the corolla, and alternating with them. Carpels 2, rarely 1 or 3.

Order 7. Gentianales.—Leaves usually opposite. Corolla regular, hypogynous. Stamens epipetalous.

This order comprises 6 families all of which are represented in India. Four of these, *viz.*, Salvadoraceae, Apocynaceae, Asclepiadaceae, and Loganiaceae, contain poisonous plants.

Order 8. Polemoniales.—Leaves usually alternate. Corolla regular, hypogynous. Stamens as many as the lobes of the corolla, epipetalous. Ovary 1–5-celled.

This order consists of 5 families all of which are represented in India. Three of these, *viz.*, Boraginaceae, Convolvulaceae (=Convolvulaceae and Nolanaceae of *E. P.*), and Solanaceae, contain poisonous plants.

Order 9. Personales.—Flowers generally very irregular. Corolla hypogynous, often 2-lipped. Stamens usually fewer than the lobes of the corolla, generally 4, didynamous, or 2. Ovary 1–2- or rarely 4-celled; ovules usually many.

This order comprises 8 families of which 7 are found in India, but only 3 contain poisonous plants. These are: Scrophulariaceae (=Scrophulariaceae—in greater part— of *E. P.*), Bignoniaceae, and Pedaliaceae (=Pedaliaceae and Martyniaceae of *E. P.*).

Order 10. Lamiales.—Corolla generally 2-lipped, hypogynous, rarely regular. Stamens usually fewer than the lobes of the corolla, generally 4, didynamous, or 2. Ovary 2–4-celled; ovules solitary in loculi, or rarely more than 1 in the family Verbenaceae. Fruit a drupe or nutlets.

Of the 4 families belonging to this order, 3 are represented in India, but only 2 contain poisonous plants. These are: Verbenaceae (=Verbenaceae and Phrymaceae of *E. P.*) and Labiatae.

Anomalous family.—Under this is included 1 family which is represented in India, but it does not contain any poisonous plant.

3. Monochlamydeae or Incompletae.—Flowers generally with one whorl of perianth, commonly sepaloid, or wanting.

Exceptions.—Corolla present in *Loranthus* and in a few representatives of the Euphorbiaceae family. In *Euphorbia*, several male flowers surrounding a single female flower are enclosed within a common involucre. In the genus *Ficus*, the minute unisexual flowers are attached to the inner walls of a hollow fleshy receptacle.

SERIES I. CURVEMBRYAE.—Terrestrial plants with usually bisexual flowers. Stamens usually as many as the perianth-segments, rarely fewer or more. Ovule generally solitary in the ovary, or 1 in each cell. Embryo curved in the generally farinaceous albumen.

This series comprises 7 families of which 6 are represented in India, but only Chenopodiaceae (=Chenopodiaceae and Basellaceae of *E. P.*), Phytolaccaceae, and Polygonaceae contain poisonous plants.

SERIES II. MULTIOVULATAE AQUATICAE.—Aquatic herbs, submerged. Ovary syncarpous; ovules many.

This series includes only 1 family, which is represented in India, but does not contain any poisonous plant.

Series III. Multiovulatae Terrestres.—Terrestrial plants. Ovary syncarpous ; ovules many.

This series comprises 3 families all of which are represented in India, but only Aristolochiaceae contains poisonous plants.

Series IV. Micrembryeae.—Ovary syncarpous, monocarpous, or apocarpous ; ovules usually solitary. Embryo very small, surrounded by copious albumen.

This series consists of 4 families all of which are represented in India. Only Piperaceae (=Piperaceae, Saururaceae, and Lactoridaceae of *E. P.*) and Myristicaceae of these, however, contain poisonous plants.

Series V. Daphnales.—Trees or shrubs, very rarely herbs. Ovary generally monocarpellary ; ovules solitary or few. Perianth perfect, sepaloid, 1–2-seriate. Stamens perigynous.

This series includes 5 families of which 4 are represented in India. Of these, however, only Lauraceae (=Lauraceae and Hernandiaceae of *E. P.*) and Thymelaeaceae contain poisonous plants.

Series VI. Achlamydosporeae.—Ovary unilocular, 1–3-ovuled ; ovules generally poorly developed before flowering and not apparent till after fertilization. Seeds albuminous, but devoid of testa, either free in the pericarp or attached to its walls.

This series comprises 3 families all of which are represented in India. Only Loranthaceae, however, contains poisonous plants.

Series VII. Unisexuales.—Trees or shrubs, rarely herbs. Stipules generally present. Flowers unisexual. Perianth sepaloid or much reduced or absent. Ovary syncarpous or monocarpellary ; ovules solitary or 2 per carpel. Seeds albuminous or exalbuminous.

This series includes 9 families of which 7 are represented in India. Of these, 6 with poisonous plants are : Euphorbiaceae (=Euphorbiaceae and Buxaceae of *E. P.*), Urticaceae (=Urticaceae, Moraceae, Ulmaceae, and Cynocrambaceae of *E. P.*), Platanaceae, Juglandaceae, Myricaceae, and Cupuliferae (=Betulaceae and Fagaceae of *E. P.*).

Anomalous Families.—Here are included 4 families of doubtful or unknown affinities ; they have unisexual flowers. Two of these are represented in India, but nothing is known with regard to the poisonous properties of their representatives.

II. Gymnosperms

Trees or shrubs, usually resinous. Stem with pith surrounded by concentric layers of wood and bark and increasing in girth as in Dicotyledons. Leaves generally needle-shaped. Flowers always unisexual. Perianth generally wanting (except Gnetaceae). Ovules and seeds not enclosed in an ovary, but are borne naked on the surface of open carpels (scales), or on the axis of a cone. Seeds albuminous, cotyledons 2–many.

In this group are included three families all of which are represented in India, but only Gnetaceae and Coniferae (=Taxaceae and Pinaceae of *E. P.*) contain poisonous Indian representatives.

III. Monocotyledons

Herbs, rarely shrubs or trees. Stems with scattered vascular bundles traversing the cellular tissue, not increasing in girth except in certain arborescent Liliaceae. Leaves usually simple and narrow, generally with parallel venation and a sheathing base. Whorls of perianth 3-merous. Ovules enclosed in an ovary in which they mature and ripen into seeds, as in Dicotyledons. Embryo with 1 seed-leaf or cotyledon; radical not elongating to form a taproot, but emitting secondary roots from its crown.

Exceptions.—Pinnate or flabellate leaves occur in Palmae. In Araceae and Taccaceae the leaves are often pedate, but if they are broad and simple, the venation is usually palmate with secondary nerves straight and transverse, rarely reticulate. Leaves with reticulate venation also occur in *Dioscorea*, some Liliaceae, and in a few other families. The flowers are occasionally 2-merous in Gramineae.

Series I. Microspermae.—At least the inner series of the perianth petaloid. Ovary inferior, unilocular, with 3 parietal placentas, or rarely 3-celled with axile placentation. Seeds very small, numerous, exalbuminous.

This series includes three families all of which are represented in India, but nothing is known about the poisonous properties of their members.

Series II. Epigynae.—Flowers bisexual (except Dioscoreaceae). Perianth in 2 whorls, one or both petaloid. Ovary usually inferior, 1–3-celled. Albumen copious.

This series comprises 7 families all of which are represented in India, but only Bromeliaceae, Iridaceae, Amaryllidaceae (=Amaryllidaceae and Velloziaceae of *E. P.*), Taccaceae, and Dioscoreaceae contain poisonous plants.

SERIES III. CORONARIEAE.—Flowers rarely unisexual. At least the inner series of the perianth petaloid. Ovary superior, 3-celled. Albumen copious.

This series includes 8 families of which 6 are represented in India. Of these, only Liliaceae contains poisonous plants.

SERIES IV. CALYCINAE.—Perianth small, sepaloid, herbaceous or membranous. Ovary superior. Albumen copious.

This series consists of 3 families all of which are represented in India, but only Juncaceae and Palmae contain poisonous plants.

SERIES V. NUDIFLORAE.—Perianth absent or reduced to scales or bristles. Ovary superior; carpels solitary or, if many, syncarpous, 1–many-ovuled. Albumen usually present.

This series includes 5 families of which 4 are represented in India, but only Araceae contains poisonous plants.

SERIES VI. APOCARPAE.—Perianth in one or two series or absent. Ovary superior, of 1 or more distinct carpels. Albumen absent.

This series consists of 3 families all of which are represented in India, but nothing is known with regard to the poisonous properties of their members.

SERIES VII. GLUMACEAE.—Flowers in the imbricating bracts of heads or spikelets, 1- or 2-sexual. Perianth small, scale-like, or glumaceous, or absent. Ovary 1-celled and 1-ovuled, or divided into 1-ovuled loculi. Seeds albuminous.

This series comprises 5 families of which 3 are represented in India. Only Cyperaceae and Gramineae of these 3 are dealt with in this monograph on account of some of their Indian representatives being known as poisonous.

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Family I.—RANUNCULACEAE

(Buttercup or Crowfoot Family)

Botanical characters

Annual or perennial herbs, rarely shrubs, usually with acrid juice. Leaves radical, alternate or (Tribe Clematideae) opposite. Flowers regular or irregular, usually showy. Sepals 5 or more, rarely fewer, often petaloid, deciduous (persistent in *Paeonia*). Petals 0, or 3–5 or more, often minute or deformed. Stamens usually numerous. Carpels many, rarely 1, free or rarely coherent; stigma simple, usually sessile. Fruit of numerous 1-seeded beaked or plumose achenes, or of many-seeded follicles, rarely a berry. Seeds small; albumen copious.

Distribution

Abundant in the temperate and cold regions, rare in tropical climes.

Toxic aspects

Many members of this family are poisonous and have been found to contain toxic principles. Although most of the Indian species have not been worked out, it is advisable to regard them, especially when they are fresh, as potential poisons both for man and animals. Poisonous, acrid, vesicant, purgative, and narcotic properties are met with in varying degrees throughout the family. Most species, however, lose their acrid property on drying or boiling in water. The family is not an economically important one. Some of the members, *e.g.*, larkspur (*Delphinium*), columbine (*Aquilegia*), and virgin's-bower (*Clematis*), are cultivated for ornamental purposes. Some species, such as those belonging to the genera *Aconitum*, *Hydrastis*, *Helleborus*, *Delphinium*, *Coptis*, and *Nigella*, are used in medicine. The seeds of *Nigella sativa* Linn. ('kalonji') are used as a condiment.

Many plants, such as those belonging to the genera *Anemone*, *Caltha*, *Clematis*, and *Ranunculus*, contain the lactone anemonin, which has blistering properties. The toxic properties of aconites (*Aconitum*) were known to the ancients. Various species, most of which are poisonous, grow in different parts of the world and contain powerful alkaloids, such as aconitine, indaconitine, pseudaconitine, etc. Some of them, however, contain nonpoisonous alkaloids, such as atisine and palmatisine. The poisonous alkaloids of aconites act mainly on the sensory nerves and medulla oblongata, which they first depress and ultimately paralyze. Species of *Delphinium* have been used for the destruction of vermin and contain several alkaloids of which the most important are delphinine, which appears to act like aconitine, and staphisagroine, which paralyzes the motor nerves in the same manner as curare. Alkaloids are also known to occur in the genera *Caltha*, *Clematis*, *Isopyrum*, and *Paeonia*. *Adonis* and

Helleborus contain certain glucosides, such as adonidin and helleborein, with an action similar to digitalis. Saponins occur extensively in the genus *Clematis* and are also reported to have been found in the genera *Ranunculus*, *Nigella*, and *Cimicifuga*. Cyanogenetic compounds have been reported from some members of the family. The Indian representatives from which these compounds have been reported belong to the genera *Clematis*, *Aquilegia*, *Isopyrum*, and *Ranunculus*.

Constituents

The members of this family have been found to contain: (*a*) *alkaloids*, such as aconitine, indaconitine, pseudaconitine, japaconitine, mesaconitine, hypaconitine, jesaconitine, lappaconitine, bikhaconitine, berberine, palmatine, columbamine, delphinine, delphisine, staphisagroine, ajacine, celliamine, sprintillamine, sprintilline, hydrastine, canadine, etc., (*b*) *glucosides*, such as adonin, adonidin, helleborin, helleborein, etc., (*c*) *saponins*, such as those found in the genera *Cimicifuga*, *Clematis*, *Nigella*, and *Ranunculus*, (*d*) *cyanogenetic compounds*, such as those found in *Aquilegia*, *Isopyrum*, and *Ranunculus*, and (*e*) *toxic lactone* anemonin, found in the genera *Anemone*, *Caltha*, *Clematis*, and *Ranunculus*.

KEY TO THE GENERA*

A. Carpels 1-ovuled. Fruit of many achenes.	
I. Climbing shrubs. Leaves opposite. Petals 0 ..	8. *Clematis*.
II. Herbs. Leaves radical or alternate.	
a. Sepals petaloid.	
aa. Flowers involucrate. Petals 0 ..	4. *Anemone*.
bb. Flowers not involucrate. Petals 5–16 ..	3. *Adonis*.
b. Sepals herbaceous, 3–5. Petals usually 5, with basal glands	12. *Ranunculus*.
B. Carpels many-ovuled. Fruit of 1–more follicles (berried in *Actaea*).	
I. Flowers regular or nearly so.	
a. Flowers solitary or panicled.	
aa. Leaves undivided. Petals 0 ..	6. *Caltha*.
bb. Leaves divided.	
1. Sepals deciduous.	
i. Petals small, clawed ..	10. *Nigella*.
ii. Petals as large as the sepals, all spurred	5. *Aquilegia*.
2. Sepals persistent. Carpels 1–5, girt by a fleshy disc	11. *Paeonia*.
b. Flowers racemed.	
aa. Carpels solitary, berried when ripe ..	2. *Actaea*.
bb. Carpels 4–8, follicular when ripe ..	7. *Cimicifuga*.
II. Flowers very irregular.	
a. Posterior sepal spurred	9. *Delphinium*.
b. Posterior sepal vaulted	1. *Aconitum*.

* The roots of *Helleborus niger* Linn., a foreign plant, are imported into India. This plant is, therefore, also discussed in detail.

1. ACONITUM Tourn. *ex* Linn.

(Etymology obscure, perhaps from the Greek *akontion*—a dart ; referring to some species which are used to poison arrows.)

Botanical characters

Biennial or perennial, rarely annual, erect, rarely twining herbs. Leaves palmatipartite, rarely entire. Flowers irregular, racemed, blue, purple, white or yellow. Sepals 5, petaloid, posterior (helmet) vaulted, the rest flat, 2 anterior narrower than the lateral. Petals 2–5 (represented by nectaries on long stalks) ; 2 posterior clawed, limb hooded and enclosed in the helmet, 3 lower small or obsolete. Stamens many. Follicles 3–5, sessile. Seeds many ; testa spongy, rugose or wrinkled.

Distribution

North temperate zone.

Toxic aspects

Most of the Indian species growing in the Himalayas are highly poisonous, but they also have medicinal properties. A number of investigations, botanical, chemical and physiological, have been made on the Indian and European aconites. In the present work we have adopted the classification of Indian aconites as given by Stapf (*1*). Twenty-four Indian species have been described and a number of these have been shown to contain poisonous alkaloids. Preparations of different kinds of aconite roots are stated to have been used as arrow poisons by the Chinese and probably also by the aborigines of ancient Gaul. The roots of some of these have been extensively used by wild tribes inhabiting the hills from Assam to Kashmir to poison arrows for killing tigers, bears, and other wild animals, as well as for intertribal conflicts. During one of the military expeditions to the North-Eastern frontier of Sikkim, Bhutan and Assam, a number of sepoys were mortally wounded by such poisoned arrows. Some of these plants are also responsible for many deaths annually among the livestock, especially sheep and goats, which are taken to the hills in summer for grazing. They are normally not eaten, and shepherds take special care in keeping their charges off the plants ; nevertheless they are occasionally consumed. Cases of poisoning among sheep and goats from *Aconitum chasmanthum* Stapf *ex* Holmes are occasionally met with in Kashmir and Lahul where the plant grows plentifully in a wild state.

Distribution of alkaloids

All parts of an aconite plant, especially the root, contain alkaloids which are responsible for its poisonous properties. In the case of *A. napellus* Linn., roots, seeds, and leaves are poisonous in a descending order (*2*). It is possible that other aconites also behave in the same way, but this has not been definitely ascertained.

Pharmacology of aconitines

The chief active constituent of *Aconitum napellus* Linn. (European aconite) is the alkaloid aconitine. It has been investigated by Wright and his collaborators (*3*), who prepared several of its salts and examined its hydrolytic products, and later by Dunstan and his collaborators (*4*, *5*), by Freund and Beck (*6*), and by Schulze (*7*).

Commercial " aconitine ", generally prepared from *A. napellus*, may represent mixtures of aconitine and its decomposition products in varying proportions, some samples being a hundred times more active than others. This enormous variability is most unfortunate in a substance of so great a toxicity, and several fatal accidents have led to the practical abandonment of the internal use of aconitine in therapeutics. Considered qualitatively, all the aconitines behave more or less uniformly. As their action is complicated, the action of aconitine only is described as a representative of the group.

When rubbed into the skin in the form of an ointment, or applied to mucous membranes or taken internally, aconitine has a characteristic action on all sensory nerves. At first the nerve endings are stimulated with the characteristic prickling and tingling sensation. After a short time the action is reversed and the nerve endings are paralyzed. The action on the heart is altered in a composite and obscure manner. After the administration of small quantities the heart does not seem to be affected in man, while in maximal therapeutic amounts it is often accelerated through the nausea induced by its irritant effect on the stomach. Its action on the respiratory centre appears to be a direct one ; it is paralyzed before the heart begins to fibrillate. The higher centres appear to be almost unaffected by the drug and consciousness is often retained to the end. The muscular weakness and depression felt after small quantities appear to arise from nausea and not from any direct action on the nerves. Some of the lower centres in the medulla are directly affected, *e.g.*, the cardio-inhibitory centre, vasomotor centre and vomiting centre ; they are all excited by large amounts, though therapeutic doses have no effect on them. The secretion of saliva is greatly increased. Aconitine sometimes reduces the body temperature, but the precise way in which this action is effected is unknown.

Therapeutic uses

Aconite was formerly used in therapeutics to slow the pulse and reduce the temperature, but its action is very uncertain. The effects on the sensory nerve endings suggested its local use in the treatment of neuralgia, and there is some evidence that its application to local parts may give some relief in this condition. Its systemic use, however, is not advisable. Effective doses are almost always toxic and

safe doses are seldom, if ever, effective. The lethal dose of aconitine per kgm of body weight for rabbits is 0·000139 gm and for guinea pigs 0·00012 gm. The oral administration of 0·2 mgm induces distinct symptoms in man.

Other alkaloids

Indaconitine.—This is the characteristic alkaloid of *A. chasmanthum* Stapf *ex* Holmes. Its physiological action (*8*) resembles that of aconitine, differing from the latter only in degree.

Pseudaconitine.—This is an important alkaloid found in *A. balfourii* Stapf and *A. deinorrhizum* Stapf. Its action closely resembles that of the above two alkaloids but is more intense, being about 2·2 to 2·5 times that of aconitine (*9*).

Bikhaconitine.—This is the crystalline alkaloid found in *A. spicatum* Stapf. Its physiological action differs in degree and not in kind from the above three alkaloids, being intermediate in toxicity between pseudaconitine and indaconitine. Bikhaconitine closely resembles aconine, its physiological action essentially resembling curare in character (*8*).

Poisoning

Accidental poisoning with aconite, sometimes with fatal results, is occasionally met with because of its common occurrence in the bazars and its use by quacks in the treatment of fever. Cases of poisoning have also occurred from the use of country liquor, to which it is occasionally added, in the same way as datura for the purpose of enhancing its intoxicating power. Homicidal cases are not infrequently reported, but are not so common as one would expect, considering how easily the drug can be obtained and how well known its poisonous properties are. It is sometimes administered to the victim with betel leaf to disguise its tingling taste.

Symptoms of poisoning in man

The symptoms of aconite poisoning usually begin to manifest themselves a few minutes after the poison is taken and in some respects are quite peculiar and characteristic. A minute particle invisible to the naked eye, if accidentally blown into the eyes, sets up a very painful irritation and flow of tears, lasting for several hours and accompanied by disturbances of the heart's action. If inhaled, a like amount will produce great bronchial irritation or profuse sneezing and considerable catarrh. If any part of a poisonous aconite plant be chewed, it will be found to have a taste which may be at first bitterish sweet, but after a time becomes acrid and burning, causing a persistent sense of tingling and numbness of the gums and tongue. This effect lasts for some time and is highly characteristic. With very large doses death may occur almost instantaneously, probably from paralysis of the heart. With moderately toxic doses there is a tingling in the mouth, stomach and skin, excessive salivation, nausea, retching, vomiting, and diarrhoea.

The mechanism of the emesis is central (*10*). The burning sensation changes into anaesthesia, there is great restlessness, the pulse is slow and feeble, later arhythmic and very rapid. The respiration is dyspnoeic, there is muscular weakness, inco-ordination, and vertigo. The skin is cold and livid ; the pupils are at first constricted and then dilated from the effects of asphyxia and convulsions. Intelligence does not usually suffer, but there may be stupor and even unconsciousness. Special senses and speech may be impaired ; convulsions are common. Death may occur from paralysis of the heart or of the respiratory centre (the heart keeps on beating for some time after death). The symptoms may appear almost instantaneously and are rarely delayed beyond an hour. In fatal poisoning, death occurs usually in two to six hours. There are no constant *post-mortem* changes.

Symptoms of poisoning in animals

In the horse there is champing and a copious salivation with choking movements of the oesophagus, eructation of frothy matter and continued attempts to vomit ; the gait is staggering. Intense colic, purgation and spasmodic contractions of the diaphragm are observed. Paralysis follows, respiration becomes difficult, pulse is weak and pupils are dilated. There is loss of power, convulsions, and death from asphyxia. In the dog aconite poisoning is marked by salivation, nausea, vomiting, and purgation. The jaws are champed ; heart's action and respiration become progressively weaker.

Post-mortem appearance

Marked gastro-enteritis is not found in cases of acute poisoning. The lungs contain little blood and are collapsed ; they are extensively studded with patches of extravasated blood ; the air passages contain frothy mucus. The right chambers of the heart are engorged, the left more or less empty.

Treatment

In cases of poisoning, the stomach must be emptied at once. Atropine has been found to alleviate the symptoms and not infrequently to lead to recovery after doses which would otherwise have been fatal. The symptomatic treatment should be mainly stimulating. *In extremis*, cardiac stimulants should be used intravenously. Warmth and friction often assist in stimulating the heart.

Nonpoisonous alkaloids

Atisine (*11*) and *palmatisine* (*12*) are the nonpoisonous alkaloids isolated from *A. heterophyllum* Wall. and *A. palmatum* D. Don respectively. Atisine is not poisonous in the usual sense, very large doses being required to produce death. Its physiological action has been investigated by Cash and shown to be somewhat similar to that of aconine. The roots of *A. heterophyllum* have a bitter taste and are employed in Indian medicine as a mild tonic, antiperiodic, and aphrodisiac. Palmatisine resembles atisine in being bitter and nonpoisonous.

The following alkaloids are also found in other foreign species of *Aconitum*: anthorine, cynoctonine, japaconitine, lappaconitine, lycaconitine, mesaconitine, myoctonine, napelline, neopelline, paniculatine, septentrionaline, etc. *Alkaloids in foreign aconites*

The twenty-four species of Indian aconites described by Stapf (*1*) are :— *Indian aconites*

Sec. I. Lycoctonum :—

1. *A. laeve* Royle, 2. *A. luridum* Hook. *f.* & Thoms., 3. *A. moschatum* Stapf.

Sec. II. Napellus :—

4. *A. soongaricum* Stapf, 5. *A. chasmanthum* Stapf *ex* Holmes, 6. *A. violaceum* Jacquem. *ex* Stapf, 7. *A. hookeri* Stapf, 8. *A. rotundifolium* Kar. & Kir., 9. *A. heterophyllum* Wall., 10. *A. naviculare* Stapf, 11. *A. palmatum* D. Don, 12. *A. deinorrhizum* Stapf, 13. *A. balfourii* Stapf, 14. *A. falconeri* Stapf, 15. *A. spicatum* Stapf, 16. *A. laciniatum* Stapf, 17. *A. ferox* Wall. *ex* Ser., 18. *A. heterophylloides* Stapf, 19. *A. leucanthum* Stapf, 20. *A. elwesii* Stapf, 21. *A. lethale* Griff., 22. *A. nagarum* Stapf, 23. *A. dissectum* D. Don. (Position of nos. 22 and 23 is uncertain as they are imperfectly known.)

Sec. III. Gymnaconitum :—

24. *A. gymnandrum* Maxim.

Stapf also referred three doubtful species to this genus.

A perusal of the following will show that no information is available regarding several of the Indian aconites, but most of them are poisonous, and it should be worth while examining authentically identified specimens.

KEY TO THE SPECIES*†—after Stapf (*1*)

A. Root perennial, long, fusiform, usually breaking up at length into cord-like anastomosing or free strands. Old plants often with several stems from the collar.

I. Upper sepal distinctly helmet-shaped, produced into a long deflexed or subhorizontal beak.

a. Helmet high, linear-oblong or oblong in profile. Nectaries extinguisher-shaped, hood oblique, much shorter than the claw .. .. 8. *A. laeve*.

b. Helmet depressed, broad, hemi-elliptic in profile. Nectaries hammer-shaped, hood as long as the claw .. .. .. 10. *A. luridum*.

* Specific descriptions given later should be read along with the key, since the two are complementary to each other.

† Roots of European *A. napellus* Linn. are available in Indian bazárs. This plant, therefore, has also been dealt with separately.

II. Upper sepal navicular, obliquely erect. Nectaries extinguisher-shaped, hood erect, short, broad .. 11. *A. moschatum.*

B. Roots biennial, paired, tuberous ; each tuber producing normally one simple or (rarely) branched stem.

I. Stem erect, rarely ascending, never twining.

a. Seed-angles winged, faces smooth or almost smooth (not transversely lamellate).

aa. Tubers $\frac{4}{5}$–$1\frac{2}{5}$ in. long, fracture (in the dry state) horny or cartilaginous, brown (at least the part outside the cambium) ; taste slightly bitter, followed by a tingling sensation. Carpels glabrous or nearly so, never tomentose.

1. Carpels 3, diverging after flowering 12. *A. soongaricum.*

2. Carpels 5, conniving .. .. 2. *A. chasmanthum.*

bb. Tubers $\frac{1}{5}$–1 in. long, fracture (in the dry state) almost farinaceous, pure white ; taste indifferent or slightly sweetish, not followed by any tingling sensation. Carpels densely tomentose. Nectary-hood erect ; honey-gland subterminal 14. *A. violaceum.*

b. Seeds with hyaline wavy transverse lamellae.

aa. Cambium of tubers discontinuous, forming in cross section circular or tangentially flattened to horseshoe-shaped strands.

1. Inflorescence and carpels greyish pubescent. Leaves divided almost to the base, ultimate divisions narrow. Carpels usually 3 .. 3. *A. deinorrhizum.*

2. Inflorescence and carpels spreadingly yellowish tomentose. Leaves rather less divided than in the preceding species, ultimate divisions broad. Carpels 5 .. 1. *A. balfourii.*

bb. Cambium of tubers continuous, forming in cross section a more or less sinuous ring.

1. Secondary sieve-strands of mother-tubers not encased in sclerenchymatic sheaths. Lip of nectary widened from the base upwards. Leaf-segments not or slightly divaricate.

i. Leaves divided to $\frac{6}{7}$ in the inner, to $\frac{3}{4}$ or less in the outer incisions, ultimate divisions rather broad. Carpels 5. Follicles $\frac{2}{5}$–$\frac{4}{5}$ in. long.

§ Intermediate leaf-division rhomboid-cuneate, sparingly and coarsely inciso-crenate. Nectary-hood much leaning forward, slightly widened at the top, scarcely gibbous. Carpels glabrous or nearly so. Follicles $\frac{2}{5}$–$\frac{4}{5}$ in. long 5. *A. falconeri.*

§§ Intermediate leaf-division mostly ovate in outline, copiously inciso-crenate or dentate. Nectary-hood slightly leaning forward, distinctly gibbous at the top. Carpels villous. Follicles about $\frac{3}{5}$ in. long .. .. 13. *A. spicatum.*

ii. Leaves divided almost to the very base, ultimate divisions narrow. Carpels mostly 3. Follicles $\frac{4}{5}$–1 in. long .. 7. *A. laciniatum.*

2. Secondary sieve-strands of mother-tubers encased in sclerenchymatic sheaths, forming persistent fibres. Lip of nectary narrow. Leaf-segments conspicuously divaricate .. .. .. 6. *A. ferox.*

II. Stem very slender, twining.

a. Flowers on recurved pedicels (up to 2 in. long), nodding. Helmet conic-ovate in profile .. 4. *A. elwesii.*

b. Flowers on straight or almost straight pedicels (up to 3 in. long). Helmet depressed semi-orbicular in profile .. .. .. 9. *A. lethale.*

1. Aconitum balfourii Stapf

A. ferox, Fl. Brit. Ind., I, 28, in part.

Vernacular names : Darma—Gobriya ; Garhwal—Banwa ; Nepal—Gobari.

Botanical characters

Roots paired or ternate, tuberous. Daughter-tubers sometimes paired or divided from the base, conic or elongate conico-cylindric, $1\frac{1}{5}$–$2\frac{4}{5}$ in. long, $\frac{2}{5}$–$\frac{4}{5}$ in. thick with a few root-fibres, externally greyish-brown, fracture white, almost horny, cambium discontinuous, broken up into strands arranged in a ring; mother-tubers wrinkled, often with numerous root-fibres. Stem erect, several ft. high, straight, simple. Leaves orbicular, ovate-cordate or subreniform, 4–$4\frac{4}{5}$ in. across, 3-partite to $\frac{7}{8}$, divisions variously lobed, all lobes coarsely inciso-crenate or dentate, crenae apiculate or acute. Inflorescence up to 1 ft. long. Sepals blue. Carpels 5. Follicles slightly divergent above, otherwise contiguous. Seeds trigonous, broadly winged along the raphe.

Distribution

Found in the subalpine and alpine Himalayas from British Garhwal to Nepal at altitudes of 7,500 to 14,000 ft.

Constituents

The examination of a sample from Dudatoli (British Garhwal) showed that the daughter-tubers contained nearly 1 per cent and the mother-tubers 0·5 per cent of pseudaconitine (*1*). The air-dried roots

were found to contain about 1·2 per cent of total alkaloids of which 0·4 per cent was crystalline pseudaconitine (*13*).

FIG. 1. *Aconitum balfourii* Stapf

2. **Aconitum chasmanthum** Stapf *ex* Holmes

Vernacular names: JHELUM—Mohri, Piun; KASHMIR—Banbalnag, Mohri.

Botanical characters

Roots paired, tuberous. Daughter-tuber conic to conic-cylindric from a broad base, rarely up to 2 in. long, $\frac{1}{2}$–$\frac{3}{4}$ in. thick, bearing more or less numerous root-fibres leaving behind the indurated bases when breaking off, bark brown to blackish-brown, smooth or wrinkled when dry, fracture cartilaginous, hard, white within the cambium ring, brownish without; mother-tuber shrunk, deeply grooved and wrinkled, black outside, brown right through. Stem erect, simple, 2–4 ft. high. Leaves numerous, lower longer petioled, lower and intermediate orbicular-reniform, $1\frac{3}{5}$–$2\frac{2}{5}$ in. high and 2–$3\frac{3}{5}$ in. across, 3-palmatipartite

FIG. 2. *Aconitum chasmanthum* Stapf *ex* Holmes

almost to the very base, segments divided, ultimate laciniae linear, acute to very acute. Inflorescence a long, narrow, stiff raceme, often over 1 ft. long. Sepals blue or whitish and variegated with blue. Carpels 5. Follicles contiguous or with slightly divergent tips. Seeds unequally 3-winged.

Distribution Abundant in the alpine and subalpine zones of the Western Himalayas from Chitral and Hazara to Kashmir, between altitudes of 7,000 and 12,000 ft.

Constituents It was formerly considered to be identical with *A. napellus* Linn., the European species, to which it is closely allied. The roots have been found to contain about 4·3 per cent of alkaloids (*14*). Indaconitine is the characteristic alkaloid of this species. An aconitine which resembles indaconitine has been isolated from a Kashmir specimen (*15*).

3. **Aconitum deinorrhizum** Stapf

Vernacular names: BUSHAHR—Maura, Mohra.

Botanical characters Roots paired, tuberous. Daughter-tuber conical, rather elongate, up to $2\frac{3}{5}$ in. long, up to $\frac{4}{5}$ in. thick at upper end, with very few root-fibres, fracture scarcely farinaceous, whitish, cambium discontinuous, broken up into strands arranged in a ring; mother-tuber more or less shrunk, wrinkled. Stem several ft. high, erect, straight. Leaves up to 10 or 12, scattered, reniform or ovate-reniform, 5-pedatipartite almost to the base (to $\frac{15}{16}$–$\frac{19}{20}$ in the inner, to $\frac{3}{4}$–$\frac{7}{8}$ in the outer incisions), divisions subdivided and ultimate ones narrow. Raceme up to $1\frac{1}{3}$ ft. long. Sepals blue. Carpels 3, conniving in flower, then subdivaricate.

Distribution Found in the alpine Himalayas of Bushahr.

Constituents A sample of the root from Bushahr yielded about 0·9 per cent of total alkaloids of which 0·4 per cent was pseudaconitine (*13*).

4. **Aconitum elwesii** Stapf

A. uncinatum (?). Fl. Brit. Ind., **I**, 28, *non* Linn.

Vernacular name: LACHUNG—Tukschak-gniong.

Botanical characters Stem scandent, branched, flexuous. Leaves 3-partite to $\frac{7}{8}$–$\frac{9}{10}$, lateral divisions unequally 2-lobed, all coarsely crenate, crenae apiculate; petioles flexuous. Inflorescence axillary and terminal, racemose or subpaniculate, pendulous or nodding. Sepals blue or violet. Carpels 5, conniving, glabrous. Follicles (immature) divergent.

Distribution Found in the alpine Himalayas of the North-Eastern Sikkim; also in the Naga Hills, Chingkhu at an altitude of 9,000 ft.

J. D. Hooker remarks on the label attached to his Lachung specimen "good Bikh" from which it may be inferred that the local people regard it as a strong poison (*1*). *Toxicity*

FIG. 3. *Aconitum deinorrhizum* Stapf

5. Aconitum falconeri Stapf

A. ferox, Fl. Brit. Ind., I, 28, in part.

Vernacular names : GARHWAL—Bis, Bikh, Meetha-tellia.

Roots paired, tuberous. Daughter-tuber conic to cylindric from a broad, truncate base, up to $3\frac{1}{5}$ in. long to $\frac{4}{5}$ in. thick, entire or divided, bearing more or less numerous filiform root-fibres, fracture white, slightly farinaceous or horny; mother-tuber much shrunk and wrinkled. Stem erect, simple, up to $3\frac{1}{3}$ ft. high. Leaves scattered, *Botanical characters*

10 or more, $4\frac{4}{5}$–6 in. across, lower and intermediate rotundate-cordate to reniform, 5-subpedatipartite to $\frac{6}{7}$ or more in the inner to $\frac{3}{4}$ or more in the outer incisions, inner divisions 3-, outer 2-lobed and laciniate. Inflorescence 6–8 in. long, few-flowered. Sepals blue with very dark tips (in the dry state). Carpels 5, conniving, soon slightly divergent. Seeds obconic, winged along the raphe.

Distribution

Found in the subalpine and alpine zones of the Himalayas of Garhwal.

Toxicity

The root is considered to be poisonous. According to Stapf (*1*), the variety *latilobum* Stapf, found in Bushahr, is evidently the plant referred to by Watt when he quotes Minniken as saying that " it is called *Kala-mohra* in allusion to its being a more deadly poison than the *mohra* ".

6. **Aconitum ferox** Wall. *ex* Ser.*

Fl. Brit. Ind., I, 28, in part.

Vernacular names: ARABIC—Bish; ASSAM—Bish; BENGAL—Bish, Butsnab-bish, Kat-bish; BOMBAY—Butchnab; CUTCH—Buchnaga; GUJERAT—Shinga-dio-vachnag, Vachhanag, Vachnag; HINDI—Bachhnag, Bachnak, Bis, Bish, Mahoor, Mitha zahar, Singya, Singya-bis, Teliya-bis; KANARESE—Vasanabhi, Vatsanabhi; LEPCHA—Nyine; MALAYALAM—Vatsanabhi; MARATHI—Bachnag, Vachnag; NEPAL—Atisingeea-bish, Bik, Bikma, Bikh, Bish, Bishnak; PERSIAN—Bishnag, Zahar; SANSKRIT—Vatsanabha, Visha; TAMIL—Vashanavi; TELUGU—Ativasa, Nabhi, Vasanabhi.

Botanical characters

Roots paired, tuberous. Daughter-tuber ovoid-oblong to ellipsoid, 1–$1\frac{3}{5}$ in. long, about $\frac{2}{5}$–$\frac{3}{5}$ in. thick, with a few filiform root-fibres, fracture scarcely farinaceous, yellowish; mother-tuber much shrunk and wrinkled. Stem erect $1\frac{1}{3}$–3 ft. high. Leaves scattered, up to 8 in. across, orbicular-cordate to reniform, 5-pedatipartite to the very base or almost so in the inner, and to $\frac{8}{9}$–$\frac{9}{10}$ in the outer incisions, intermediate divisions 3-lobed to the middle, outermost 2-lobed or 2-partite, all further incised, laciniae more or less linear-lanceolate and divaricate. Inflorescence a loose raceme, 4–10 in. long. Sepals blue. Carpels 5, conniving and contiguous. Follicles conspicuously reticulate. Seeds obovoid to obpyramidal, winged along the raphe.

Distribution

Found in the alpine Himalayas of Nepal; recently collected from Assam.

Toxicity

As the specific name implies, the plant has the reputation of being extremely poisonous. It is probably the source, or one of the sources of the 'bish', 'bikh' or 'hodoya bish' of Hamilton (*16*), but it is not his " *Caltha codua* ".

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* Formerly the name *A. ferox* was given to more than one species, and it is likely that the vernacular names given here refer to some other species as well.

7. Aconitum laciniatum Stapf

Vernacular name : SIKKIM—Kalo-bikhmo.

Botanical characters

Roots paired, tuberous. Daughter-tuber conic-oblong, often rather drawn out into a slender point, $1\frac{2}{5}$–$2\frac{2}{5}$ in. long, about $\frac{3}{5}$–$\frac{4}{5}$ in. thick, simple or divided, fracture whitish or pale-brownish, almost horny ; mother-tuber much shrunk and thinner. Stem erect, 2–3 ft. high. Leaves scattered, 3–5 in. across, reniform, 5-pedatipartite almost to the base in the inner, to $\frac{3}{4}$–$\frac{5}{6}$ in. the outer incisions, divisions lobed and inciso-dentate or laciniate. Inflorescence racemose or usually loosely paniculate. Sepals saturated red-purple or dark red. Carpels 3, rarely 4 or 5, conniving in flower. Follicles at first divergent, then conniving, contiguous. Seeds obpyramidal, broadly winged along the raphe.

Distribution

Found in the subalpine and alpine Himalayas of Sikkim and adjoining Tibet.

Toxicity

According to Rogers, quoted by Stapf (*1*), it forms together with 'bikh' (*A. spicatum*) the article known as "Nepal Aconite". It is very difficult to sort small tubers of *A. spicatum* from large ones of this species, although the plants are easily distinguished by their foliage, flowers, and fruit.

8. Aconitum laeve Royle

A. lycoctonum, Fl. Brit. Ind., I, 28, *non* Linn.

Botanical characters

Stem erect, up to 6 ft. high. Basal and lower leaves up to 1 ft. across, orbicular-cordate or reniform, 5–9-subpedatipartite to $\frac{5}{6}$ in. the inner and to $\frac{3}{4}$ in. the outer incisions, lobes acutely inciso-dentate ; petioles long below, rapidly decreasing in upper leaves. Inflorescence panicled, often over $1\frac{2}{3}$ ft. long. Sepals yellowish or white and tinged with purple or blue or wholly purplish. Carpels 3. Follicles divergent. Seeds elliptic-oblong, finely transversely rugose (not hyaline-lamellate).

Distribution

Found in the Himalayas from Chitral to Kumaon, mostly in forests, locally abundant, at altitudes of 5,000 to 12,000 ft. ; also at Piri (Balipara Frontier Tract) at 10,000 ft.

Toxicity

In the "Flora of British India" this plant is described as *A. lycoctonum* Linn. Stapf (*1*) has shown that the Indian species differs from *A. lycoctonum* of North and North-East Europe. Jowett's notes, quoted by Watt (*17*), refer to the chemistry of the European *A. lycoctonum*. It is possible that the Indian species, which was formerly considered to be the same as the European, is also poisonous. According to Dr. Bor, however, the Daflas do not ascribe any poisonous properties to its roots. The roots of *A. laeve*, do not appear to be used medicinally and their chemistry is unknown.

9. **Aconitum lethale** Griff.

A. palmatum, Fl. Brit. Ind., I, 28 (The Mishmi Plant), *non* D. Don

Botanical characters — Roots fusiform, whitish or brown, bearing root-fibres. Stem scandent (?), branched, flexuous. Leaves cordate-rotundate, 3-partite to $\frac{5}{6}$ (or the small leaves of the branches 5-lobed to the middle), lateral divisions unequally divaricate-2-lobed to the middle, all coarsely dentate, teeth apiculate. Carpels 5, sparingly pubescent.

Distribution — Found in the higher elevations of the Mishmi mountains.

Toxicity — This, according to Griffith, is the source of celebrated 'bhi' or 'bis' poison of the Mishmis (*1*).

10. **Aconitum luridum** Hook. *f.* & Thoms.

Fl. Brit. Ind., I, 28.

Vernacular names: BENGAL—Bish, Butsnab-bish; BHUTAN—Tchendook; BOMBAY—Butchnab; HINDI—Mahoor; NEPAL—Atisingeea-bish, Bikh, Bishnak; TELUGU—Ativassa.

Botanical characters — Stem erect, up to $2\frac{2}{3}$ ft. high, few-leaved. Basal and lower leaf-blades rarely up to 5 in. across, orbicular-cordate or reniform, 5-palmatipartite to $\frac{3}{4}$ (in the largest to $\frac{6}{7}$), inner divisions 3-, outermost 2-lobed; lobes sparingly and acutely inciso-dentate or apiculate-crenate. Inflorescence racemose, up to $1\frac{1}{3}$ ft. long, rather dense, rarely with a few additional branches from the base. Sepals lurid, reddish or brownish-red to purple without, yellowish within. Carpels 3. Follicles erect, contiguous. Seeds triquetrous, angles unequally winged.

Distribution — Found in the Himalayas from Eastern Nepal to Chumbi at altitudes of 12,000 to 14,000 ft.

Toxicity — According to J. D. Hooker, as quoted by Stapf (*1*), the root is said to be as potent as that of *A. ferox* and *A. napellus*.

11. **Aconitum moschatum** Stapf

Botanical characters — Stem erect, up to 3 ft. high, few-leaved. Stem-leaves very similar to the basal except for much shorter petioles; blades up to $3\frac{3}{5}$ in. across, orbicular-cordate or subreniform, 5-palmati- or subpedati-partite to $\frac{2}{3}$ in the inner and to $\frac{1}{2}$ in the outermost incisions; inner divisions 3-lobed, outermost unequally 2–4-lobed; lobes sparingly and coarsely inciso-crenate, crenae obtuse, apiculate. Inflorescence racemose, rarely with an additional branch from the base, up to $1\frac{1}{3}$ ft. long, lax. Sepals lurid purple. Carpels 3. Follicles (not quite mature) contiguous except at the tips. Seeds obpyramidal, with crisp hyaline transverse lamellae.

Distribution — Found in Eastern Kashmir between altitudes of 12,000 and 14,000 ft.

Stapf (*1*) marks it as one of those species which are known to be or are suspected as poisonous, but its properties are unknown. *Toxicity*

Aconitum napellus Linn., *non* Fl. Brit. Ind.

(Monkshood, Wolfsbane)

This is the European species the roots of which are imported and sold in this country. Aconitine is a characteristic crystalline alkaloid found in its roots. There are two other amorphous bases which yield crystalline salts. The content of the alkaloid in the roots varies from 0·296 to 2·971 per cent according to the source, season, etc. Alkaloidal content has been reported to be quite high at the time of flowering or before complete flowering (*18*). The leaves, flowers, and seeds also contain aconitine, but in a lesser degree (*19*). *Constituents*

12. Aconitum soongaricum Stapf

Botanical characters

Roots paired, tuberous. Daughter-tuber with very few root-fibres, brown, fracture horny, cambium continuous, forming a scarcely sinuous ring in cross section; mother-tuber similar, more or less shrunk. Stem erect, simple, up to $2\frac{1}{3}$ ft. high. Leaves scattered, longer petioled below, more or less cordate-orbicular or reniform, 5-partite to the very base or in the outer incisions almost to the base; inner 3 divisions 3-lobed or pinnati-laciniate, lobes or laciniae broad-linear, subobtuse to shortly acute, entire or the larger with 1–2 coarse teeth or linear lobules; outer divisions 2-fid beyond the middle, inner segments (subdivisions) 2–3-lobed, outer often entire. Inflorescence an erect terminal raceme $2\frac{1}{2}$–7 in. long or with additional branches from upper leaves. Sepals blue. Carpels 3, somewhat diverging.

Distribution

Found in the alpine regions of the mountain ranges of Gilgit and Turkistan.

Toxicity

Its properties and uses are unknown, but of all the Indian species of *Aconitum* this comes nearest to *A. napellus* Linn. of Europe. In fact this species has several times been referred to as *A. napellus* in Indian literature. If *A. napellus* be taken in a broad sense, *A. soongaricum* might perhaps be included in it as a variety, the principal difference being in the small size and shape of the tubers and the peculiar long-beaked helmet. There is strong reason to suspect that its roots are poisonous.

13. Aconitum spicatum Stapf

A. ferox, Fl. Brit. Ind., I, 28, in part.

Vernacular names: SIKKIM—Bikh, Gniong-mot, Shodduk-mot.

Botanical characters

Roots paired, tuberous. Daughter-tuber conic or conic-oblong, often rather elongated, 4–8 in. long, $\frac{4}{5}$–$1\frac{1}{5}$ in. thick, simple or sometimes deeply divided, fracture horny, yellowish or brown in dry state; mother-tuber shrunk and wrinkled. Stem up to 2 ft. high. Leaves

orbicular-cordate or reniform or broadly ovate (especially the upper), 3-partite to $\frac{4}{5}$–$\frac{6}{7}$ or the upper to $\frac{2}{3}$, lateral divisions very unequally 2–3-partite to $\frac{2}{3}$–$\frac{5}{6}$, all divisions much inciso-dentate or laciniate with acute dentate laciniae. Inflorescence racemose or often panicled, many-flowered. Sepals saturated blue, more rarely pale- or purplish-blue. Carpels 5. Follicles contiguous. Seeds obpyramidal, winged along the raphe.

Distribution

Found in the alpine zone of the Himalayas of Sikkim and Chumbi at altitudes of 10,000 to 12,000 ft.

Toxicity and constituents

According to Stapf (*1*), this plant is the principal source of the 'bikh' or 'bish' of the Calcutta market. The poisonous principle is bikhaconitine, the undried roots containing about 0·6 per cent of ether-soluble alkaloids which consist chiefly of bikhaconitine (*20*). It is very difficult to sort small-sized tubers of this plant from large-sized ones of *A. laciniatum* although the two plants can easily be distinguished by foliage, flower, and fruit.

14. **Aconitum violaceum** Jacquem. *ex* Stapf

A. *napellus*, var. *multifidum* and var. *rigidum* (in part), Fl. Brit. Ind.. 1, 29.

Vernacular names: SUTLEJ BASIN—Tilia-kachang, Dudhia.

Botanical characters

Roots paired, tuberous. Daughter-tuber ovoid to shortly fusiform, $\frac{1}{3}$–$\frac{4}{5}$ in. long, $\frac{1}{6}$–$\frac{1}{4}$ in. thick, bearing a few fine root-fibres, breaking off easily, bark smooth, fracture pure white, cambium forming a central strand, circular or elliptic in cross section; mother-tuber shrunk, grooved and wrinkled, brownish internally. Stem erect or ascending, epigaeous part up to 1 ft. high. Leaves few, all except the uppermost long-petioled, 1–2 in. across, orbicular-cordate or reniform, 5-palmati- or subpedati-partite almost to the base, segments multifid. Inflorescence a short, few-flowered raceme or corymb or reduced to a solitary flower. Sepals violet, blue or yellowish and variegated with blue. Carpels 5, conniving. Follicles contiguous. Seeds 3-sided, angles winged.

Distribution

Found in the alpine zone of the Himalayas from Gilgit to Kumaon, between altitudes of 10,000 to 15,000 ft.

Toxicity

Kirtikar and Basu (*21*) remark that the root is reputed to be poisonous, but Stapf (*1*) gives just the opposite information.

2. ACTAEA (Tourn.) Linn.

(From *aktea*, the Greek name of the elder; referring to a resemblance in foliage and fruit.)

Botanical characters

Erect perennial herbs. Leaves alternate, ternately compound. Flowers small, crowded in short racemes. Sepals 3–5, rather un-

equal, petaloid. Petals 4–10, small or 0. Stamens many. Carpel 1, many-ovuled; stigma sessile, dilated. Berry many-seeded. Seeds depressed.

North temperate regions. *Distribution*

Actaea spicata Linn.

Fl. Brit. Ind., **I**, 29.

(Baneberry, Grapewort, Herb Christopher)

A perennial 2–3 ft. high. Leaves 1 ft. long; leaflets $\frac{1}{2}$–2 in., ovate to ovate-lanceolate, entire or 3-lobed, acutely serrate. Flowers *Botanical characters*

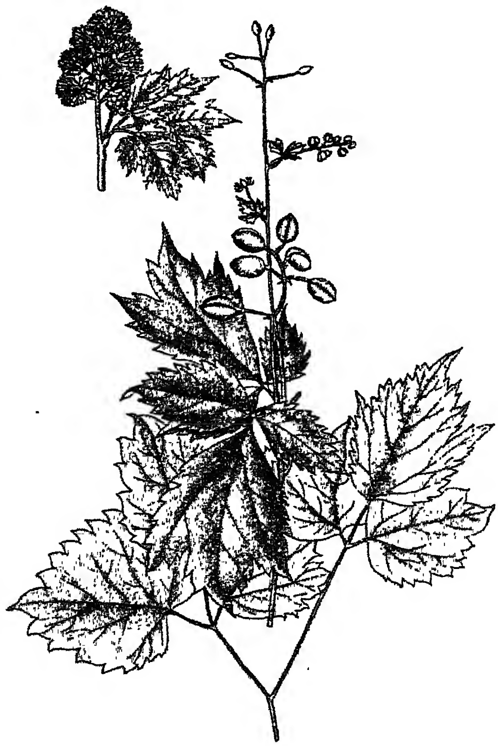

FIG. 4. *Actaea spicata* Linn.

white, $\frac{1}{4}$ in. diam., crowded in short terminal racemes. Petals 4, shorter than sepals. Berry ellipsoid, about $\frac{1}{2}$ in.

Distribution Found in the temperate Himalayas from Bhutan to Hazara.

Toxicity The European and Himalayan forms have black berries while those of the American forms are white and red. In popular scientific works, the latter two are treated as distinct species—*A. alba* and *A. rubra*. The berries are believed to be very poisonous, and fatal cases amongst children have been reported in foreign countries (*22*). Bacon has reported dizziness, increased pulse, burning in the stomach and colicky pains, as a result of eating half a dozen berries (*22*). Stewart (*56*), however, remarks that this plant is not dreaded by the hill people in the Punjab. It would appear from this that further investigation is needed. The plant is largely used in medicine abroad. The roots are said to be violently emetic and purgative. In some parts of Europe, the powdered leaves, stems, and flowers are used as insecticides.

Constituents The toxic principle is stated to be the oil of baneberry (*23*).

3. ADONIS Dill. *ex* Linn.

(The classical name.)

Botanical characters Annual or perennial herbs. Leaves much divided. Sepals 5–8, petaloid. Petals 5–16, yellow or red, eglandular. Carpels many; style short; ovule 1, pendulous. Fruit a spike or head of many achenes tipped with a short persistent style.

Distribution Temperate regions.

Economic and toxic aspects Indian species are met with only in the Western Himalayas, and are not known to be of any economic importance. Some of the species are known to contain glucosides having an action similar to digitalis, and a few are stated to contain saponins. Cases of poisoning among horses, due to eating the tops of *A. aestivalis* Linn. and other species in hay, have been reported from Europe.

Adonis vernalis Linn., a foreign species, was stated to contain the poisonous glucoside adonidin (*24, 25*). Later investigations have shown the presence of two other glucosides, adonidoside and adonivernoside. These glucosides resemble digitalis or ouabain in their action on the excitability, conductivity and contractility of the heart, but differ in intensity and duration (*26*). The lethal dose of adonidin is 0·476 mgm per kgm of body weight for cats (*27*), that of adonidoside is 0·70 mgm per kgm for dogs, and of adonivernoside 1·75 mgm per kgm (*28*). The therapeutic dose of *A. vernalis* is 3 to 6 grains in powder form and 4 drachms of an infusion (1 in 40). Adonidin is used in doses of $\frac{1}{4}$ to $\frac{1}{2}$ gr daily; 5 mgm of adonidin in 0·5 per cent solution has been employed as an efficient diuretic in cardiac anasarca. Adonidin is a local anaes-

thetic. In iritis of chronic glaucoma and in iridocyclitis 1 per cent solution has been used, 3 drops being instilled to relieve pain. *A. vernalis* has no special advantage over digitalis, but can be used as a substitute. Preparations made from leaves, stem, and seeds are not so readily absorbed from the gastro-intestinal tract, and are more actively emetic than digitalis (*29*).

KEY TO THE SPECIES

a. Annual. Flowers scarlet with a dark-purple eye .. 1. *A. aestivalis*.
b. Perennial. Flowers golden-yellow .. .. 2. *A. chrysocyathus*.

1. Adonis aestivalis Linn.

Fl. Brit. Ind., I, 15.

Botanical characters

An erect annual herb 1–2 ft. high. Leaves decompoundly pinnate, segments filiform. Flowers about ½ in. diam., scarlet with a dark-purple eye, solitary at the ends of branches. Achenes deeply pitted, angular, with a tooth on the inner angle near the beak.

Distribution

Found in the Western Himalayas as a weed of cultivation, especially in the rice fields.

Toxicity and constituents

This plant has been reported as having been responsible for poisoning horses in Europe. It contains 0·216 per cent of an amorphous glucoside which resembles adonin, the glucoside found in *A. amurensis* Regel & Radde, in its properties. It is also qualitatively similar in action to that of adonidin obtained from *A. vernalis*, but is very much weaker (*30*).

2. Adonis chrysocyathus Hook. *f.* & Thoms.

Fl. Brit. Ind., I, 15.

Vernacular names : KASHMIR—Marnil, Nilmar.

Botanical characters

A very handsome perennial growing in tufted form, with numerous graceful pinnately decompound leaves, and several leafy stems each bearing a large solitary golden-yellow flower 2 in. or more in diam. Achenes not angular, turgid, flattened anteriorly, dorsally convex and obtusely keeled; style tapering revolute.

Distribution

Found in the alpine Western Himalayas in Chamba, Kashmir, and Western Tibet.

Toxicity

Beautiful fields of this plant are met with near Zojpal, on the way to the Amarnath Caves in Kashmir. In Kashmir it is known as 'nilmar' or 'marnil', and is commonly dreaded by the shepherds who believe that it causes frequent deaths among sheep and goats

A casual experiment carried out by the authors showed that it is not toxic to goats, but this cannot be regarded as conclusive since the plant was gathered after seeding. It is quite likely that the leaves are injurious in early spring.

FIG. 5. *Adonis chrysocyathus* Hook. *f.* & Thoms.

4. ANEMONE Linn.

(From the Greek *anemos*—wind; so named from being easily stripped of its petaloid sepals by the wind.)

Botanical characters

Perennial herbs. Leaves radical, lobed or divided. Flowers single or several together on simple or branched scapes; involucre 3-partite, bracts free or connate. Sepals 4–20, petaloid. Petals 0. Stamens numerous, o .ter sometimes deformed or petaloid. Carpels many; ovule 1, pendulous. Fruit a head of sessile achenes.

Distribution

Cold and temperate regions, very rare in the Southern Hemisphere,

Economic and toxic aspects

Some of the species under this genus owe their toxic properties to the presence of anemonin, which is obtained from the essential oil by steam distillation of the fresh plant.

Anemone pulsatilla Linn., a European species, was formerly largely used for dysmenorrhoea and amenorrhoea and for the treatment of asthma, hemicrania, etc., in doses of 0·1 to 0·4 gm, but is obsolete now. The sharp burning taste and irritant action of the fresh plant is supposed to be due to the presence of protoanemonin, which changes into anemonin soon after its isolation (*31*). Anemone camphor (protoanemonin) is probably the active ingredient which is responsible for its beneficial effects in neuralgia and mental depression. It has been described as the "vegetable bromide" (*32*). In anaesthetized animals an intravenous injection of anemonin quickly arrests respiration and is soon followed by a stoppage of the heart's action. It has a depressant action on the excised uterus.

Pulsatilla is believed by some to be one of the most useful of plant remedies and is largely used in homoeopathic medicine.

Anemone obtusiloba D. Don

Fl. Brit. Ind., I, 8.

Vernacular names: JAUNSAR—Ageli; KUMAON—Kakriya, Ratanjota, Rattanjog; PUNJAB—Padar, Ratanjota, Rattanjog.

Botanical characters

A densely tufted perennial herb; rootstock woody, fibrous. Radical leaves suborbicular, deeply cordate, 3-partite; segments broad, sessile. Scapes 1–3-flowered; flowers 1–2 in. across, white, blue or, at higher altitudes, yellow. Achenes coarsely hairy, not embedded in wool.

Distribution

Found in the temperate and alpine Himalayas, from Kashmir to Sikkim at altitudes of 7,000 to 15,000 ft.

Toxicity

The root of this plant is acrid and is stated to be used as a blistering agent in Bushahr; it is likely to produce sores and scars. The seeds, if given internally, produce vomiting and purging.

Constituents

A specimen of an air-dried plant examined by the authors was found to contain very small quantities of a substance whose properties resembled anemonin.

5. AQUILEGIA (Tourn.) Linn.

(From the Latin *aquila*—an eagle; referring to the claw-like spurs.)

Botanical characters

Erect, perennial-rooted herbs. Leaves ternately compound. Flowers regular, handsome, drooping, white, purple or yellow. Sepals 5, regular, coloured. Petals 5, funnel-shaped, produced into spurs at the base.

Stamens many, inner reduced to scales. Carpels 5 or more, sessile; ovules many. Follicles many-seeded. Seeds with a crustaceous testa.

Distribution North temperate regions.

Aquilegia vulgaris Linn.

Fl. Brit. Ind., I, 24.

(Columbine)

Botanical characters Graceful, usually branched herb up to 3 ft. high. Leaves biternately compound. Flowers large, drooping, blue or white. Spur of petals gradually narrowed to a point. —In the "Flora of British India" six subspecies are mentioned.

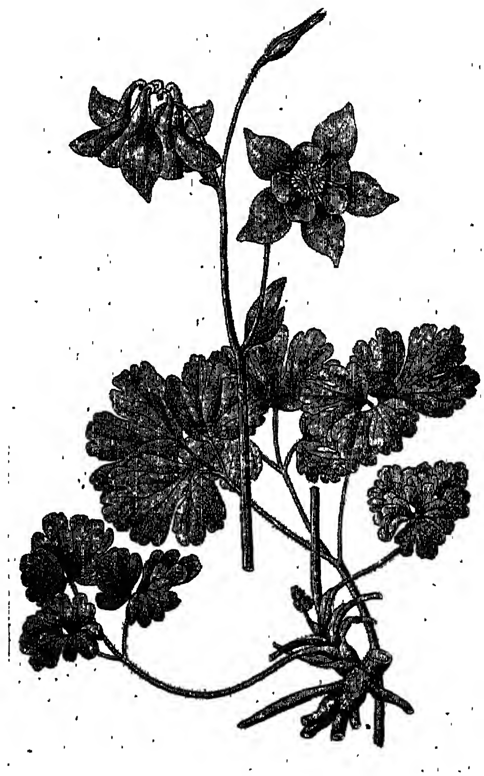

FIG. 6. *Aquilegia vulgaris* Linn.

Distribution Found in the temperate and subalpine Himalayas.

Toxicity and constituents According to Cornevin, quoted by Lander (*19*), this plant is accredited with poisonous properties. The flowering plant has been found to

contain a cyanogenetic compound (*33*). No alkaloid has been detected in the herb (vegetative parts), flowers or seeds (*34*).

6. CALTHA (Rupp.) Linn.

(From the Greek *calathos*—a cup; referring to the shape of the flower in the common species.)

Botanical characters

Herbs with stout creeping rootstocks. Leaves chiefly radical, ovate or cordate. Flowers few, terminal, white or yellow. Sepals 5 or more, petaloid. Petals 0. Stamens many. Carpels several, sessile. Follicles many, many-seeded.

Distribution

Temperate regions.

Caltha palustris Linn.

Fl. Brit. Ind., I, 21.

(Cowslip, Marsh Marigold, Water Buttercup)

Vernacular names: PUNJAB—Baringu, Mamiri.

Botanical characters

A robust aquatic branched perennial, 1 to 2 ft. high. Leaves glossy, chiefly radical, 2–5 in. across, long-stalked, orbicular, reniform

FIG. 7. *Caltha palustris* Linn.

or deltoid, deeply cordate ; stem-leaves smaller ; upper sessile. Flowers white (rarely yellow in India), terminal, 1–2 in. diam.

Distribution The white-flowered variety (var. *alba*) is commonly met with in the marshes of the temperate Western Himalayas from Kashmir to Nepal at altitudes of 7,500 to 10,000 ft.

Toxicity and constituents In Hazara district the root is considered to be poisonous. Indian specimens have not been properly worked out, but foreign plants have been found to contain anemonin. No alkaloid was detected but a large amount of choline was present (*35*). Recent unpublished work at the Calcutta School of Tropical Medicine shows that very small amounts of an alkaloid were present in the samples analyzed. Most of the species of *Caltha* are acrid and poisonous, but this property is not developed in the young plants. The toxic property is destroyed on drying or boiling. In the Pyrenees and Germany, the young buds are pickled in the same way as capers. Some authors think that this plant causes a falling off in the yield of milk of cows feeding on it. Poisoning of horses has been recorded by Miller, and cattle have died from eating it. Generally, however, animals refuse it, presumably on account of its acrid taste (*2*).

7. CIMICIFUGA Linn.

(From the Latin *cimex*—a bug, and *fugare*—to drive away.)

Botanical characters Erect perennial herbs. Leaves 2–5-ternately divided. Flowers in long slender racemes. Sepals 4–5, deciduous, petaloid. Petals (or transformed stamens) 1–8, small, clawed, 2-horned at the tip. Stamens many, filaments slender. Carpels 1–8, many-ovuled. Follicles many-seeded.

Distribution North temperate regions.

Cimicifuga foetida Linn.

Fl. Brit. Ind., I, 30.

(Bugbane)

Vernacular name : Punjab—Jiunti.

Botanical characters A tall robust perennial 3–6 ft. high. Leaves 6–10 in. ; leaflets 2–3 in., ovate or lanceolate, serrate, terminal often 3-lobed. Flowers yellowish, ¼ in. diam., in long curved racemes or panicles. Follicles 4–8, ½ in long.

Distribution Found from Bhutan to Kashmir at altitudes of 7,000 to 12,000 ft.

Toxicity The root is said to be poisonous. In Siberia it is used to drive away bugs and fleas. The flowers and unripe fruits of the plant have an extremely foetid smell whence its specific name.

There is reason to believe that the Indian species, which differs from *C. racemosa* (Linn.) Nutt. (black snakeroot or black cohosh) only very

FIG. 8. *Cimicifuga foetida* Linn.

slightly, may possess the same properties. The rhizome and rootlets of *C. racemosa* are official in the United States Pharmacopoeia; in large doses they produce nausea and vomiting and depress the action of the heart. In one case abortion is reported to have followed its administration.

Constituents

Recent work has shown that the rhizome of *C. racemosa* contains a highly soluble acid saponin, a glucosidic tannin, a water-soluble glucoside, and a glucoside insoluble in water but soluble in alcohol; the last-named glucoside has a toxic action on the heart (of dogs), its lethal dose when given intravenously being 20 to 30 mgm per kgm (*36*). Intravenous injections of a suspension of the fluid extract of cimicifuga

produce marked depression of circulation and respiration (*37*). It is also stated to contain an essential oil.

8. CLEMATIS Dill. *ex* Linn.

(From the Greek *klema*—a vine branch ; most species are climbers.)

Botanical characters

Shrubs, usually climbing by means of their twisted petioles. Leaves opposite, usually pinnately compound and ending in a terminal leaflet. Flowers solitary or fascicled or panicled. Sepals usually 4, petaloid. Petals 0. Stamens many. Carpels numerous, distinct. Fruit a head of sessile or stalked achenes, with long usually feathery styles.

Distribution

All temperate regions, rarer in the tropics.

Toxic aspects

Some of the Indian species are known to contain an acrid principle and it is quite probable that the same is present in others also. Most members of this genus are acrid and poisonous ; the leaves and fresh stems, if crushed and applied to the skin, produce vesication ; in some species the seeds have purging properties. These acrid and irritant properties may be attributed to the presence of anemonin or similar substances which are found in the plants so far investigated. Hydrocyanic acid has also been reported from some of the species (*38*), and some species are known to contain saponins. The foreign species, *C. angustifolia* Jacq. and *C. integrifolia* Linn., were found to contain anemonin (*39*). *C. angustifolia* has narcotic properties and also contains an unidentified alkaloid (*40*).

It is interesting to note that *C. vitalba* Linn. is used in France by mendicants to produce artificial sores for the furtherance of their impostures. *C. brachiata* Thunb., found in South Africa, is acrid and the leaves when chewed produce a burning feeling in the mouth ; bruised stems, if sniffed, induce sneezing due to the pungency of the plant. Drenching experiments on cattle by Burtt-Davy (*41*) have, however, proved to be negative from the toxicological point of view.

KEY TO THE SPECIES

A. Flowers in axillary fascicles, pedicels 1-flowered .. 3. *C. napaulensis.*

B. Flowers in axillary panicles.

I. Filaments glabrous.

a. Silky. Flowers $1\frac{1}{2}$–2 in. diam. .. .. 5. *C. triloba.*

b. Usually glabrous, young parts pubescent. Flowers $\frac{1}{3}$–$\frac{1}{2}$ in. diam. .. .. 1. *C. gouriana.*

II. Filaments hairy.

a. Glabrous except the flowers. Leaves pinnately decompound. Sepals elliptic, obtuse .. 2. *C. graveolens.*

b. Glabrous, glaucous. Leaves pinnate or 2-pinnate. Sepals ovate, acuminate .. .. 4. *C. orientalis.*

c. Softly downy. Leaves pinnate. Sepals broadly ovate .. .. 6. *C. wightiana.*

1. Clematis gouriana Roxb.

Fl. Brit. Ind., I, 4.

(Indian Traveller's-joy)

Vernacular names : BOMBAY—Moriel, Morvel, Ranjai ; KANARESE—Telejadari ; UNITED PROVINCES—Belkangu, Belkum ; URAN—Golarang ; URIYA—Boro-mojhanti, Idiya.

Botanical characters

An extensive, usually glabrous climber, young parts pubescent. Leaves pinnate, 2-pinnate or 3-pinnate ; leaflets ovate-oblong, cordate,

FIG. 9. *Clematis gouriana* Roxb.

acuminate, shining above. Flowers $\frac{1}{3}$–$\frac{1}{2}$ in. diam., yellowish or greenish-white, in much-branched, decompound panicles. Filaments glabrous ; connective not produced. Achenes hairy, with long feathery tails.

Distribution Found in the Western Himalayas up to an altitude of 5,000 ft., and in hilly districts throughout India between 1,000 and 3,000 ft.

Toxicity This plant abounds in an acrid poisonous principle. The leaves and fresh stems, if crushed and applied to the skin, produce vesication.

2. Clematis graveolens Lindl.

Fl. Brit. Ind., I, 4.

Vernacular name: BALUCHISTAN—Hushokawal.

Botanical characters A slender climber, glabrous except the flowers. Leaves pinnately decompound. Leaflets ½–1 in., toothed or incised, or 3-lobed or -partite, terminal segment oblong. Panicles 3–7-flowered; upper flowers often solitary. Flowers 1½–2 in. diam., pale-yellow, heavy-odoured. Sepals elliptic, obtuse, pubescent outside, densely tomentose inside. Filaments hairy; connective not produced. Achenes pubescent, with long feathery tails.

Distribution Occurs in Baluchistan, extending in the temperate Western Himalayas as far as Kumaon at altitudes of 6,000 to 11,000 ft.

Toxicity This plant is considered as poisonous in Baluchistan.

3. Clematis napaulensis DC.

Fl. Brit. Ind., I, 2.

Vernacular names: KUMAON—Ghantiali, Jai, Kanguli: PUNJAB—Birri, Pawanne, Wandak.

Botanical characters An extensive, slender, nearly glabrous climber. Leaves ternately divided; leaflets 1–2 in., elliptic-lanceolate, sometimes very narrow, entire, toothed or 3-lobed, 3-nerved. Flowers greenish, in axillary fascicles. Pedicels with 2 connate bracts at or near the middle. Filaments glabrous. Achenes margined, hairy, with long feathery styles.

Distribution Found in the temperate Himalayas from Garhwal to Bhutan; quite common throughout Kumaon at altitudes of 4,500 to 7,000 ft., usually in shady moist ravines.

Toxicity In some places, the leaves are said to act deleteriously on the skin.

4. Clematis orientalis Linn.

Fl. Brit. Ind., I, 5.

Botanical characters A large woody climber, glabrous, glaucous, branchlets sometimes puberulous. Leaves pinnate or 2-pinnate; leaflets 1–2 in., orbicular to ovate-lanceolate or lanceolate, entire, toothed or cut. Panicles many-flowered. Flowers 1½ in. diam., yellow or mottled with purple. Sepals ovate-acuminate, villous outside or on both surfaces. Filaments silky or

ciliate; connective not produced. Achenes silkily hairy, with long feathery tails.

Distribution — Found in the dry inner valleys from the Indus to Kumaon in the Western Himalayas, ascending to a height of 14,000 ft., and in Western Tibet.

Constituents — Hydrocyanic acid has been reported from this plant (*38*).

5. **Clematis triloba** Heyne *ex* Roth

Fl. Brit. Ind., I, 3.

Vernacular names: BOMBAY—Moravela, Moriel, Morvel, Ranjae, Ranjai; GUJERATI—Morvel; HINDI—Churahar, Dhantiali, Murhari; KANARESE—Morhari; MARATHI—Moravela, Morbel, Ranjai, Ranjani; PORBANDAR—Trekhdovelo; SANSKRIT—Laghukarni; SIND—Maruva.

Botanical characters — An extensive climber; whole plant except the older stems silky. Leaves simple or once ternate, entire or shallowly 1–7-lobed; blades 1–2 in., elliptic-ovate or cordate, 3-nerved. Flowers white, $1\frac{1}{2}$–2 in. diam., in axillary corymbose panicles. Sepals 4–6, stellately spreading. Filaments glabrous; connective not produced. Achenes silky-villous, with long feathery tails.

Distribution — Met with in the mountains of the Bombay Presidency, in Konkan, the Deccan and on the Western Ghats.

Toxicity — It contains an active acrid principle which can be distilled with water and is soluble in fixed oils (*42*).

6 **Clematis wightiana** Wall.

Fl. Brit. Ind., I, 5.

Botanical characters — A large woody climber, softly downy. Leaves pinnate, silky-villous; leaflets usually 5, 2 in., orbicular- or ovate-cordate, 3–5-lobed. Flowers yellow, brown-tomentose outside, 2–$2\frac{1}{2}$ in. diam., in decompound panicles. Sepals broadly ovate. Filaments silky below the middle, glabrous at the base and tip; connective not produced. Achenes silky-hairy, with long feathery tails.

Distribution — Found in the hills of the Deccan, Orissa, and Konkan; common in the Western Ghats, and the Nilgiris up to an altitude of 7,500 ft.

Toxicity — Hydrocyanic acid has been reported from this plant (*38*).

9. **DELPHINIUM** Tourn. *ex* Linn.

(From the Greek *delphinos*—a dolphin; referring to the form of the flowers.)

Botanical characters — Annual or perennial erect herbs. Leaves palmately lobed. Flowers racemed or panicled, irregular, white, blue or purplish. Sepals 5, dorsal

spurred behind. Petals 2–4, small; spurs of the 2 dorsal developed within that of the sepal; 2 lateral spurless or 0. Stamens many. Follicles 1–7. Seeds many; testa wrinkled or plaited.

Distribution

Throughout the north temperate zone, and temperate tracts of lofty mountains in the southern zone.

Toxicity and constituents

Various species of *Delphinium* (larkspurs) contain alkaloids which are closely related to aconitine, both chemically and pharmacologically. They have since time immemorial been used for the destruction of body parasites. They have been the cause of poisoning in children, and in cattle and horses (*43*). The alkaloids found in this genus are ajacine, ajaconine, delcosine, delphinine, delphinoidine, delphisine, delsoline, staphisagroine, deltaline etc.; of these delphinine and staphisagroine are the most important.

Stavesacre

Delphinium staphisagria Linn. (stavesacre) is a foreign species, the ripe seeds of which are used locally against *Pediculis capitis* or *P. pubis* in the form of a 10 per cent ointment or as a fluid extract diluted with 8 to 10 parts of soap liniment or bay rum. It causes considerable local irritation and sometimes eczema. It is used in Europe for the destruction of vermin. The seeds of this plant have an acrid taste and act as an irritant poison, their special remote action being on the cardiac and respiratory centres which are depressed.

The seeds contain the alkaloids delphinine, delphisine (isomeride of delphinine), staphisagroine, delphinoidine, and another crystalline base. Of these, delphinine occurs in the largest amount (*44*, *45*, *46*). The total quantity of the alkaloids present was found to be 1·22 to 1·35 per cent (*47*).

Delphinine is intensely poisonous, resembling veratrine and aconitine, and acts chiefly on the nervous system, first upon the medulla, next on the sympathetic. Staphisagroine, on the other hand, paralyzes the motor nerves in the same way as curare. The lethal dose of delphinine for dogs is 0·0015 gm per kgm of body weight and that of delphisine 0·0007 gm (*48*).

Poisoning with stavesacre closely resembles that by aconite but is very rare both in man and animals. Macgregor (*49*) observed a case of delphinium poisoning in a mare which showed dullness, excessive salivation, deglutition and attempts to vomit. These symptoms along with a weak pulse prove its resemblance to aconite. As an antidote, medicinal charcoal stirred up in water should be given, followed by an emetic or the use of a stomach tube.

Indian species

Most of the Indian species of *Delphinium* have not been properly investigated, but some of the popular uses in India and the beliefs and

experiences of local people strongly indicate that they are poisonous. Generally speaking, the flowers are acrid, bitter, and astringent; the seeds are emetic, cathartic, anthelmintic, and insecticidal.

KEY TO THE SPECIES

A. Spur subulate.
- *a*. Radical leaves $1\frac{1}{4}$–$1\frac{1}{2}$ in. diam. Follicles 5 .. 2. *D. caeruleum*.
- *b*. Radical leaves 4–6 in. diam. Follicles 3 .. 3. *D. elatum*.

B. Spur inflated, conical. Flowers large.
- *a*. Stem $1\frac{1}{2}$–3 ft. Flowers in long dense racemes. Follicles 3 .. .. 4. *D. vestitum*.
- *b*. Stem 6–12 in. Flowers corymbose. Follicles 5–6 .. 1. *D. brunonianum*.

1. **Delphinium brunonianum** Royle

Fl. Brit. Ind., I, 27.

Vernacular names: GARHWAL—Kasturi; KUMAON—Nepari; LADAKH—Ladara; PANGI—Mundwal; RAVI—Sapfalu; SUTLEJ—Laskar, Liokpa, Panni, Ruskar, Spet, Supalu.

Botanical characters

An erect, musky, simple herb. Stem 6–12 in., glabrous or downy below, glandular-pubescent above. Leaves 3–4 in. diam., 5-fid to the middle; lobes sharply cut or toothed. Flowers corymbose, large, pale-blue, hairy. Sepals longer than the conic spur. Follicles 5–6, $\frac{3}{4}$ in., viscidly pubescent.

Distribution

Found in the Western Himalayas and Tibet, between 13,000 and 17,000 ft. above sea level.

Toxicity

This plant is prized for its strong musky scent. In Leh, it is considered so poisonous that the dew from the leaves falling on grass is said to poison cattle and horses. Aitchison (*50*) remarks that the juice of the leaves of this plant is used in the Kurrum Agency to destroy ticks on animals, particularly on sheep. It is a curious fact that stavesacre, the foreign delphinium, was employed both by the Greeks and Romans in olden days for the destruction of vermin, and even now is largely used in Europe for this purpose.

2. **Delphinium caeruleum** Jacquem. *ex* Cambess.

Fl. Brit. Ind., I, 25.

Vernacular name: PUNJAB—Dakhangu.

Botanical characters

An erect slender herb; stem 3–12 in., much branched from the base. Leaves $1\frac{1}{4}$–$1\frac{1}{2}$ in. diam., suborbicular, 5–7-lobed; lobes cuneate-oblong, incised or pinnatifid, segments linear. Flowers 1 in. or more long, solitary in long branches, or few in a loose raceme, pale-blue, hairy.

FIG. 10. *Delphinium brunonianum* Royle.

Sepals shorter than the nearly straight subulate spur. Follicles 5, hairy.

Met with in the alpine Himalayas from Kumaon to Sikkim, and is common in the Sutlej basin at altitudes of 8,000 to 17,000 ft. *Distribution*

The root is applied to kill maggots in the wounds of goats. *Toxicity*

3. **Delphinium elatum** Linn.

Fl. Brit. Ind., I, 26.

A sparingly branched herb; stem 2–4 ft. high. Leaves 4–6 in. diam., rounded or reniform in outline, pale beneath, 5–7-lobed or -partite; segments cuneate-oblong, 3-lobed or variously cut. Racemes much branched, dense-flowered. Flowers pale-blue or purplish, hairy outside; spur equalling the subulate sepals. Follicles 3. *Botanical characters*

Found in the temperate Western Himalayas from Kashmir to Kumaon and in the inner Tibetan valleys at altitudes of 10,000 to 12,000 ft. *Distribution*

In Europe the seeds are used as an insecticide. *Toxicity*

The seeds contain about 1 per cent of alkaloids, one of which was obtained in a crystalline form and at least two other bases were identified in the uncrystallized portion (*45*). *Constituents*

4. **Delphinium vestitum** Wall.

Fl. Brit. Ind., I, 26.
Vernacular name: Simla—Juhi.

A very hairy herb; stem 1½–3 ft., usually simple. Radical leaves 6–12 in. diam., orbicular, palmately 5–7-lobed; segments lobed, sharply toothed at the end; cauline smaller. Raceme often 1 ft., bearing numerous, 1–1¼ in. long, dark-purple flowers. Sepals equalling or exceeding the conical incurved spur. Follicles 3. *Botanical characters*

It is found in the West and Central Himalayas at altitudes of 8,000 to 12,000 ft., and is more abundant on the higher levels where it is met with on exposed grassy hills. *Distribution*

The leaves are said to be poisonous to goats. *Toxicity*

HELLEBORUS (Tourn.) Linn.

(From the Greek *helein*—to cause death, and *bora*—food; referring to the poisonous properties of plants of this genus.)

The alkaloids present in this genus are celliamine, sprintillamine, sprintilline, etc., while the glucosides are helleborin, helleborein, etc. *Constituents*

Helleborus niger Linn.

(Christmas Rose)

Vernacular names: ARABIC—Khertik, Kartik, Kherbek-aswed; BIHAR—Khorasani-kutki; BENGAL—Kala-kutki; DECCAN—Kala-kutki; PERSIAN—Kherbek-siyah; SANSKRIT—Katuroum, Katurohini; TAMIL—Kadagaru-ganie; TELUGU—Katukaro-gani.

General remarks

It is a small, perennial herb with black, jointed, definite rhizomes having numerous interlacing rootlets. It is a native of Central and South Europe, extending eastwards to South Poland and westwards to Dauphiny and Provence. It is also indigenous to Greece. Several writers have recorded the plant from Nepal. They seem to have obtained this information from Ainslie who with a degree of hesitation and doubt said that the plant occurred in Nepal. As a matter of fact the plant is not at all found in India except perhaps that some specimens may be cultivated in gardens at high altitudes. The roots, however, are available in druggists' shops.

Toxicity

Hellebore is an irritant poison causing violent vomiting and purging (the latter, however, has in some cases been absent) and great collapse. Convulsions and loss of consciousness have also been observed. It is used in medicine as a drastic hydragogue cathartic and also as an emmenagogue and anthelmintic; it is only in larger doses that it acts as an acro-narcotic poison. The root, in doses of a few grains, acts as a drastic purgative and thirty grains of an aqueous extract of the root have proved fatal to an adult. The leaves are also poisonous.

Constituents and action

All parts of the plant are poisonous, particularly the root, whence the extract is made. Two poisonous glucosides have been obtained from the plant, namely, helleborin and helleborein (*51*). Helleborein is a powerful cardiac poison and its digitalis-like action depends on the presence of the acetyl group. It is not absorbed from the gastro-intestinal tract of man and, therefore, produces diarrhoea. Helleborin has no action on the heart; it irritates the mucous membrane, paralyzes the central nervous system, and is to be considered very poisonous (*52*). A new glucoside has also been isolated and is said to possess a physiological activity 20 to 40 times that of helleborein (*53*).

Symptoms in animals

Cornevin gives 9 ounces of the fresh root as a poisonous dose for horse. The dried roots, he states, are toxic in 2½ ounce doses to horse and in 120 to 150 grains to sheep. A full dose of hellebore produces in the horse and ox bloody evacuation, salivation, attempts to vomit and excessive urination. The action on the heart resembles that observed in digitalis poisoning, with periodic intervals of arrest in systole (*19*).

Post-mortem appearance

Hellebore acts as an irritant, and congestion of the fourth stomach and intestines has been recorded *post mortem*. The rumen is full, but the fourth stomach and intestines may be empty; the inflammation of the pylorus prevents the passage of food.

Treatment

The treatment consists in giving purgatives, mucilaginous draughts, stimulants and, in general, measures similar to those employed in digitalis poisoning.

10. NIGELLA (Tourn.) Linn.

(From the Latin *nigellus*—dark; probably referring to the dark colour of seeds.)

Botanical characters

Erect annuals. Leaves pinnately dissected. Flowers terminal, white, blue or yellowish. Sepals 5, petaloid. Petals transformed into nectaries, 2-fid, clawed. Carpels 3–10, connate, except sometimes at the extreme top; ovules 2-seriate. Fruit composed of 5–12 more or less united follicles. Styles long, beak-like.

Distribution

Mediterranean region; one species is cultivated and has run wild in India.

Constituents

The alkaloid damascenine and a saponin-like glucoside have been found to occur in this genus.

Nigella sativa Linn.

(Black Caraway, Black Cumin, Nutmeg Flower, Small Fennel)

Vernacular names : AFGHANISTAN—Shewadaru, Siyah-daru ; ARABIC—Habba-toussouda, Kamune-asvad, Kamune-avad, Shouniz ; BENGAL—Kala-jira, Kalo-jira, Kal-zira, Mugrela, Mungrela ; BOMBAY—Kalen-jire, Kalonji ; BURMA—Samonne ; DECCAN—Kulunjan ; GUJERATI—Kalonji-jirum ; HINDI—Kala-jira, Kalonji, Mugrela ; KANARESE—Kare-jirige, Karim-siragam ; KASHMIR—Tukmi-gandna ; MALAYALAM—Karun-chirakam ; PERSIAN—Shuniz, Siyah-danah, Siyah-biranj ; SANSKRIT—Karave, Krishna-jiraka, Sushave ; TAMIL—Karun-jiragam ; TELUGU—Nalla-jilakara.

Botanical characters

A pretty herb 1–2 ft. high. Leaves 1–2 in. long, 2–3-pinnatisect, and cut into linear or linear-lanceolate segments. Flowers pale-blue, $\frac{4}{5}$–1 in. diam., solitary, long-peduncled. Nectarial petals 8, geniculate. Capsule $\frac{1}{2}$ in. long. Seeds trigonous, rugulose-tubercular.

FIG. 11. *Nigella sativa* Linn.

Distribution Extensively cultivated in many parts of India for its seeds.

Uses and properties The seeds have a strong, pungent, aromatic taste, and are much used in India in curries and other dishes. It appears to be a common practice in this country to scatter the seeds between folds of linen or woollen clothes to prevent them from being eaten by insects.

The seeds are regarded as aromatic and carminative, and are used as an emmenagogue in Europe. It has been observed that after doses of 10 to 40 grains of the powdered seed the temperature of the body is raised, the pulse is accelerated and all secretions are stimulated, especially those of the kidneys and skin; in doses of 10 to 20 grains they possess a well-marked emmenagogue action in dysmenorrhoea, and in larger doses produce abortion (*42*).

Constituents The seeds are stated to contain 0·5 to 1·4 per cent of an essential oil and a saponin-like glucoside, melanthin.

11. PAEONIA (Tourn.) Linn.

(After *Paeon*, the physician of the gods, who is said to have first used peony medicinally.)

Botanical characters Erect, stout, leafy, perennial herbs or undershrubs. Leaves compound. Flowers large, solitary or panicled, white or red. Sepals 5, herbaceous, persistent. Petals 5–10, larger than the sepals. Stamens many. Carpels 1–5, many-ovuled. Fruit of one or more coriaceous few-seeded follicles. Seeds large, subglobose.

Distribution North temperate zone.

Constituents Small quantities of alkaloids have been found to occur in some members of this genus.

Paeonia emodi Wall.

Fl. Brit. Ind., I, 30.

(Himalayan Peony, Peony Rose)

Vernacular names: BHUTIA—Bhuma-madiya, Yet-ghas; HINDI—Udsalap; KASHMIR—Mid; PUNJAB—Mamekh; UNITED PROVINCES—Chandra; URDU—Udasaliba.

Botanical characters A stout glabrous perennial 1–3 ft. in height, with a cluster of thick fleshy roots. Leaves large, once or twice ternatisect; ultimate segments of leaves oblong or lanceolate. Flowers large, white, 3–4 in. diam., long-peduncled, usually in the axil of upper leaves. Follicles 1, rarely 2, ovoid.

Distribution Found in the temperate Western Himalayas from Hazara to Kumaon at altitudes of 5,000 to 10,000 ft. It forms lovely gregarious

FIG. 12 *Paeonia emodi* Wall.

patches in Kagan and Kashmir and, when in flower in spring, is most beautiful to look at.

Uses and properties

The tuberous roots of this plant, like those of the foreign *P. officinalis* Linn., are highly esteemed as a medicine for uterine diseases, colic, bilious obstructions, dropsy, epilepsy, etc. If taken in full doses, the drug produces headache, noise in the ears, confused vision, and vomiting. The seeds are emetic and cathartic.

Constituents

A poisonous alkaloid has been reported from the seeds and roots of *P. officinalis*. This alkaloid is stated to produce contraction of the renal capillaries and increase the coagulability of the blood (*54*). It is quite likely that the Indian species has similar poisonous principles.

12. RANUNCULUS (Tourn.) Linn.

(A diminutive of the Latin *rana*—a frog; referring to the damp situations in which some species grow.)

Botanical characters

More or less acrid, annual or perennial, land or aquatic herbs. Leaves entire, lobed or dissected; stipules membranous or 0. Flowers usually panicled, yellow (in the Indian species except in a variety of *R. aquatilis* Linn.). Sepals herbaceous, 3-5, caducous. Petals usually 5, rarely 0, often glandular near the base. Stamens many. Carpels many; style short. Fruit a head or spike of beaked or apiculate achenes.

Distribution

All temperate and cold regions.

Toxic aspects

Many members of this genus are acrid and corrosive, and it is desirable to investigate the Indian species. *R. sceleratus* Linn. and many other species of *Ranunculus* contain an acrid oily principle, which acts as a vesicant when applied to the skin. When swallowed, it acts as an irritant poison causing, in addition to the usual symptoms of irritant poisoning, depression of the heart's action, slow respiration, paralysis, and convulsions. The acrid oily substance may be separated from the plants by distillation with water; on keeping it decomposes into anemonic acid, apparently inert, and anemonin which is poisonous. On drying and exposure, the plants lose their activity after a time. Some of the plants are reported to contain cyanogenetic compounds. They also contain saponins and may be harmful if used as a feed for animals (*55*). Indeed, some of the members of this genus are known to cause severe symptoms in sheep and goats. According to Muenscher (*22*), cows poisoned by buttercups may produce bitter milk or milk with a reddish colour.

R. aquatilis Linn., an aquatic plant, is one of the few wholesome members of the family, but no domestic use appears to have been made of this plant in India. In some parts of England cows are fed on it

during the winter, and in the Indian hills where *R. aquatilis* Linn., var. *trichophyllus* Hook. *f.* & Thoms. occurs abundantly, it might possibly be used for the same purpose.

Symptoms of poisoning in animals

The first symptoms induced by ranunculus are those of gastro-enteritis, colic, nausea, vomiting, salivation, emission of black faeces, and sometimes haematuria. To these are added nervous symptoms, slowing of pulse, slow and stertorous breathing, weakening of hind limbs, blindness, and difficulty in mastication and drinking. With large doses there may be convulsions with the eyes retracted in the orbits, an exaggeration or absolute arrest of defecation, and finally death usually within 12 hours after the appearance of convulsions (*19*).

Post-mortem appearance

Post mortem, there are inflammatory lesions of the alimentary tract, particularly of the intestines. The kidneys may also be inflamed.

Treatment

Treatment with purgatives, demulcents, and stimulants is indicated.

KEY TO THE SPECIES

A. Achenes gibbous at the sides, with a long terminal beak	3. *R. falcatus*.
B. Achenes smooth or granular, not muricated or tubercled, shortly beaked.	
I. Leaves undivided, lanceolate, entire or remotely toothed	4. *R. lingua*.
II. Leaves 3-partite. Achenes turgid, not margined	6. *R. sceleratus*.
III. Leaves thrice divided. Achenes flattened, with an intramarginal rib.	
a. Receptacle of fruit glabrous	2. *R. cassius*.
b. Receptacle pilose	5. *R. pensylvanicus*.
C. Achenes densely spinous	1. *R. arvensis*.

1. Ranunculus arvensis Linn.

Fl. Brit. Ind., I, 20.

(Field Crowfoot)

Vernacular name : Punjab—Chambal, Chambul.

Botanical characters

An erect, much-branched, pale-green annual, glabrous, or silky above. Radical leaves cuneate or obovate, 3–5-toothed, soon withering ; cauline 2–3-partite. Flowers $\frac{1}{2}$ in. diam., pale-yellow. Achenes 5–10, large, flattened, obliquely obovate, not margined, densely spinous.

Distribution

Found in the Western Himalayas from Kashmir to Kumaon, also in the plains of the North-West Punjab and at Mt. Abu in Central India.

Toxicity

Stewart (*56*) states that this plant is eaten greedily by sheep and goats, but frequently produces symptoms of irritant poisoning.

Constituents

The leaves have been found to contain cyanogenetic compounds (*57*).

2. Ranunculus cassius Boiss.

R. laetus Wall., Fl. Brit. Ind., I, 19.

Botanical characters — An erect, appressedly hairy perennial, 1–2 ft. high, usually much branched, many-flowered. Radical leaves 2–4 in. across, 3-partite; segments cuneate-obovate, deeply cut; cauline sessile. Flowers 1 in. diam. Receptacle of fruit glabrous. Achenes in a globose head, many, oval, margined, not dotted; style short, straight, broad at base.

Distribution — An inhabitant of the temperate Himalayas and Western Tibet; common on the inner ranges of Sikkim only.

Toxicity — This plant is very closely allied to and is perhaps a variety of *R. acris* Linn. The properties of this plant are not known, but it is quite possible from its relation to *R. acris*, the well-known European plant, that it may have something in common with that plant. *R. acris*, like *R. sceleratus*, contains a highly acrid principle.

3. Ranunculus falcatus Linn.

Fl. Brit. Ind., I, 16.

Vernacular names: BALUCHISTAN—Wahwashu; PUSHTU—Karamghundai.

Botanical characters — Glabrous or slightly woolly annual herb. Leaves all radical, 3-fid or pinnatifid; segments narrow-linear, entire or 3-fid. Scapes 1 or more, 1–3 in., 1-flowered. Flowers small. Achenes gibbous at the sides; beak long, straight or curved.

Distribution — Found in Kashmir, the Punjab, and Baluchistan.

Toxicity — Bruised plants are said to produce blisters.

4. Ranunculus lingua Linn.

Fl. Brit. Ind., I, 16.

(Great Spearwort, Sparrowweed, Spear Crowfoot)

Botanical characters — An erect glabrous herb 2–3 ft. high. Leaves 4–8 in. long, lanceolate, entire or remotely toothed, sessile, semi-amplexicaul; veins parallel. Flowers subpanicled, 1–2 in. across. Achenes pitted; beak broad, flat.

Distribution — Met with in the temperate regions of Kashmir.

Toxicity — In Europe the leaves are applied as a blistering agent to the joints in rheumatism.

5. Ranunculus pensylvanicus Linn. *f.*

Fl. Brit. Ind., I, 19.

Botanical characters

An erect hirsute buttercup with fibrous roots, and erect hairy branched stems 1–3 ft. high. Radical and lower stem-leaves 3-foliolate, long-petioled; leaflets long-stalked, 3-partite and deeply cut into linear segments; uppermost subsessile. Flowers about 1 in. across. Receptacle pilose. Achenes in an oblong or globose head, many, not dotted, with an intramarginal rib; beak short, straight.

Distribution

Found in swamps and rice fields in the Upper Gangetic Plain, Nepal Terai, and in the Khasia Hills up to an altitude of 6,000 ft.

Toxicity

This plant is used to raise blisters.

6. Ranunculus sceleratus Linn.

Fl. Brit. Ind., I, 19.

(Celery-leaved Buttercup, Celery-leaved Crowfoot, Marsh Crowfoot, Water Celery)

Vernacular names: ARABIC—Kaf-es-saba; KUMAON—Shim; PERSIAN—Kabikaj; TIRHUT—Polica.

Botanical characters

An erect, glabrous, much-branched annual 1–3 ft. high. Leaves usually 3-partite, segments cuneate and again variously lobed or notched; cauline sessile. Flowers $\frac{1}{4}$–$\frac{1}{3}$ in. across, numerous, terminating the branchlets and from the forks. Receptacle hairy. Achenes many in an oblong head, small, rather turgid, not margined, obtuse or apiculate.

Distribution

Met with on river banks in Bengal and Northern India, in the marshes of Peshawar and in the warm valleys of the Himalayas; appears during the cold weather and remains until the break of rains.

Toxicity

The fresh plant is highly acrid and poisonous, and produces violent irritant effects if taken internally. It has been the cause of poisoning in livestock, especially cattle. The bruised leaves when applied to the skin raise blisters, and were formerly used in Europe by professional beggars to produce or maintain blisters or open sores for exciting sympathy.

The inhabitants of Wallachia use it as an edible vegetable after boiling; a remarkable fact when it is remembered that it is poisonous and a powerful vesicant when uncooked (*42*). Some authors think that this plant reduces the volume of milk production in cattle eating it.

Constituents

It contains anemonin in the essential oil (*58*).

FIG. 13 *Ranunculus sceleratus* Linn.

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Family II.—MAGNOLIACEAE

(Magnolia and Champa Family)

Botanical characters

Trees or shrubs, often aromatic. Leaves alternate, simple, with convolute stipules covering the buds and leaving a circular scar (resembling some Urticaceae) on falling, or stipules 0. Flowers axillary and terminal, solitary, white, yellow or red, often showy and fragrant, sometimes unisexual. Sepals and petals often similar, arranged in whorls of 3, soon falling. Stamens indefinite; anther-cells adnate. Carpels indefinite, free, often on an elongate axis, sometimes partly cohering and in one whorl (*Illicium*); styles usually short. Fruiting carpels baccate, follicular or dry. Seeds solitary or few; albumen granular, or fleshy and oily.

Distribution

Chiefly in tropical and temperate Asiatic mountains and North America; a few in Australia and South America.

Economic and toxic aspects

This family contains some well-known ornamental plants. Among these may be mentioned the great-flowered magnolia (*Magnolia grandiflora* Linn.) and *M. pterocarpa* Roxb. (erroneously as *sphenocarpa* in Fl. Brit. Ind.), both with white fragrant flowers. The American ornamental tulip tree or lyre tree (*Liriodendron tulipifera* Linn.), with greenish flowers, is also cultivated in some hill stations; it yields a soft fine-grained wood, known as canary whitewood, which is a valuable commercial timber. The yellow-flowered 'champa' (*Michelia champaca* Linn.) has fragrant flowers largely used for perfume, and is also frequently cultivated.

The fruit of the star anise of China (*Illicium verum* Hook. *f.*) is largely imported into India for use as condiment in cookery and for flavouring liqueurs and spirits. It is also used as a carminative in Indian medicine. The Japanese sacred anise tree or the skimmi of Japan, *I. religiosum* Sieb. & Zucc. (*I. anisatum* Linn.?), contains a poison belonging to the picrotoxin class.

The plants of this family are remarkable for their bitter, aromatic, astringent, tonic, stimulant, diaphoretic, and antiperiodic properties. Many members yield essential oils.

Constituents

Some of the important chemical constituents isolated from this family are: (*a*) *saponins*, (*b*) *bitter substances*, (*c*) *toxic substances*, such as shikimin, etc., and (*d*) *essential oils* having such constituents as anethole, safrole, cineole, pinene, phellandrene, anisic aldehyde, anisic ketone, eugenol, methyl chavicol, etc.

ILLICIUM Linn.

(From the Latin *illicium*—an allurement: referring to its aroma.)

Botanical characters

Evergreen aromatic shrubs or small trees. Leaves quite entire, pellucid-dotted; stipules 0. Flowers 2-sexual, solitary or fascicled, yellow or purplish. Sepals 3–6. Petals 9 or more, 3–many-seriate. Stamens indefinite, filaments thick. Carpels 1-seriate, 1-ovuled; style subulate, recurved. Fruit of spreading compressed hard follicles. Seeds compressed; testa hard, shining; albumen fleshy.

Distribution

In India, China, Japan, and North America.

Economic aspects

Though the star anise (*I. verum* Hook. *f.*) has long been in use in China and Japan, it has come into use in India only recently. In Europe it is chiefly employed to flavour certain spirits and liqueurs (such as *Anisette de Bordeaux*), Germany, France, and Italy being the largest consumers. In India it is used as a condiment and also as a stomachic and carminative. The fruits of this plant are occasionally adulterated with or substituted by those of *I. religiosum* Sieb. & Zucc. (*I. anisatum* Linn. ?), the Japanese sacred anise tree or poison bay, and except perhaps for this the Japanese species is of no use. In fact, even the Japanese themselves use the Chinese fruit.

Toxic aspects

Cases of poisoning among children due to the Japanese plant have been reported in Japan and in India*. In 1881 Langaard (*1*) described a new poison belonging to the picrotoxin class from the Japanese plant. His conclusions were that all parts of the plant are poisonous. This poison produces excitation of the motor centres in the medulla, and clonic convulsions analogous to those produced by picrotoxin, toxiresin, and cicutoxin. Before the occurrence of convulsions, the reflex excitability of frogs is diminished, the respiratory centre is stimulated and there is increased frequency of respiration. Small doses produce slowing of the pulse through stimulation of the cardio-inhibitory centre as well as the peripheral terminations of the vagii; the functional activity of the heart is decreased. Small doses kill by paralyzing the respiratory centre and larger ones by paralysis of the heart.

The lethal dose of the powdered seeds for dogs and cats is 0·40 gm per kgm body weight (*2*). Chloral hydrate is the best drug to be used in the treatment of poisoning, for it appears to save life when animals are poisoned by small lethal doses, although it has no effect when the dose is large.

The fruit of *I. religiosum* contains the toxic substance shikimin besides shikiminic acid, shikimipicrin, etc. (*3*). The poison shikimin

* Waddell in "Lyon's Medical Jurisprudence for India", 1928, p. 702, mentions the plant as "star-anise, *Illicium anisæum*", undoubtedly meaning this plant.

is stated to be present in the pericarp and not in the seed (*4*). An essential oil (0·4 to 1 per cent of the dried fruit) obtained from the fruit is also known to be toxic and has a disagreeable odour (*3*).

The fruits of *I. verum* contain an essential oil (*5*), and a saponin (*6*), but no shikimin (*7*).

Illicium griffithii Hook. *f.* & Thoms.

Fl. Brit. Ind., I, 40.

Botanical characters — A shrub; branches angular, glabrous. Leaves 2–4 by 1–2 in., elliptic-lanceolate, acute at both ends, coriaceous, shining. Flowers $1\frac{1}{2}$ in. diam. Perianth-segments about 24. Sepals 6, orbicular. Petals 18, outer oval, inner smaller and narrower. Carpels with a thin fleshy epicarp, woody endocarp, and short subulate incurved beak.

Distribution — Found in Bhutan and Khasia Hills at altitudes of 4,000 to 5,000 ft.

Toxicity — This plant has been reported by the Chemical Examiner to the Government of Bombay to have been found in the viscera and other exhibits in connection with medico-legal cases received in his laboratory (*8*). It deserves further investigation.

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Family III.—ANNONACEAE

(Custard-apple Family)

Botanical characters

Trees or shrubs, often climbing, frequently aromatic. Leaves alternate, simple, entire ; stipules 0. Flowers 2- rarely 1-sexual. Sepals 3, rarely 2, free or united, usually valvate. Petals usually 6, biseriate, the inner sometimes (*Annona*) absent, usually thick and fleshy. Stamens usually numerous ; filaments short or 0 ; anthers adnate ; connective often produced or dilated. Carpels 1 or more, free (connate in *Annona*) ; ovules one or more ; styles short or almost 0. Fruit of 1 or more, sessile or stalked, 1- or many-seeded, usually indehiscent carpels or rarely of coherent carpels so as to form a fleshy mass. Seeds large ; albumen copious, ruminate.

Distribution

Mainly in the tropics of Asia, Africa, and America.

Economic and toxic aspects

Polyalthia longifolia Benth. & Hook. *f.* (Indian fir, mast tree) is an evergreen avenue tree grown throughout the hotter parts of India. *Cananga odorata* (Lam.) Hook. *f.* & Thoms.* (ilang-ilang or ylang-ylang of European commerce) is a large evergreen tree cultivated in many parts of India on account of its yellow, fragrant flowers. Otto of ilang, esteemed in perfumery, is prepared from these flowers. Some species of *Artabotrys*, a genus of scandent shrubs, have also fragrant flowers ; of these, *A. uncinatus* (Lam.) Merr. (*A. odoratissimus* R. Br.) is often cultivated in gardens for its strong-scented yellowish flowers. The alkaloids artabotrine and suaveoline have been isolated from *A. suaveolens* Blume (*1*), a tall climber with creamy white flowers found in Sylhet and Chittagong. *Saccopetalum tomentosum* Hook. *f.* & Thoms. and *Miliusa velutina* Hook. *f.* & Thoms., found wild in India, yield useful timbers and their leaves are used as fodder ; the latter also produces an edible fruit. Fruits of some species of *Annona*, especially of *A. squamosa* Linn. (custard apple), are commonly eaten, and the seeds possess poisonous and insecticidal properties.

Constituents

Members of this family have been found to contain : (*a*) *alkaloids*, such as suaveoline, artabotrine, anonaine, etc., and (*b*) *essential oils* containing sesquiterpenes, pinene, benzyl alcohol, linalol, *p*-cresol, methyl salicylate, eugenol, methyl anthranilate, etc.

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* For some time this plant has been called *Canangium odoratum* (Lam.) Baill. *ex* King. But since *Cananga* Hook. *f.* & Thoms. has been conserved by the Amsterdam Congress, 1935 (*Kew Bull.*, 1940, No. 3, p. 101.), *Cananga odorata* remains the only valid name.

ANNONA Linn.

(Probably from *menona,* the Malay name.)

Botanical characters

Trees or shrubs. Leaves pellucid-dotted. Flowers solitary or fascicled, terminal or leaf-opposed. Sepals 3, small, valvate. Petals 3–6, valvate, in 2 series, or the inner series wanting; outer triquetrous, base concave. Stamens many. Carpels many, subconnate; ovule 1; style oblong. Ripe carpels confluent into a many-celled, ovoid or globose, many-seeded fruit.

Distribution

A large American and African genus of which some species have become naturalized in India.

Economic and toxic aspects

The spherical, tubercled fruit of the custard apple (*A. squamosa* Linn.), which ripens in summer, is eaten with relish all over India, and is of a more delicate flavour than the fruit of *A. reticulata* Linn., which has a smooth, slightly areolate fruit and is eaten only by the poorer classes. The seeds are poisonous and insecticidal; the bark and the root are cathartic.

KEY TO THE SPECIES

a. Fruit smooth, slightly areolate .. .. .. 1. *A. reticulata.*
b. Fruit tubercled .. .. 2. *A. squamosa.*

1. Annona reticulata Linn.

Anona reticulata Linn., Fl. Brit. Ind., I, 78.

(Bullock's-heart, Netted Custard Apple)

Vernacular names: BENGAL—Luvuni, Nona; BURMA—Awza; DECCAN—Ramphal; GUJERATI—Ramphal; HINDI—Anta, Louna, Luvuni, Nona, Ramphal; KANARESE—Ramphal; KONKANI—Andan; MALAYALAM—Manilanilam, Parankichchakka, Ramasita; MARATHI—Ramphal; SANSKRIT—Krishnabija, Lavali, Lavani, Mriduphala, Raktatvatch, Ramawhaya, Ramphala, Vasanta; SANTAL—Gom; TAMIL—Aninuna, Ramsita or Ramsitapalam, Manilayatta; TELUGU—Ramapandu, Ramaphalam, Ramasitaphalamu; URIYA—Barhial, Neua, Ramopholo, Ramositapholo.

Botanical characters

A small tree. Leaves 4–7 by 1–1¾ in., oblong-lanceolate, larger and more pointed than in *A. squamosa,* with a few scattered hairs beneath; nerves 15–18 pairs. Flowers 2–4, on lateral pedicels. External petals 1¼ in. by ¼ in., the internal minute. Fruit 4–6 in. diam., subglobose or somewhat heart-shaped, roughish outside, yellow or yellowish-red when ripe, the areoles pentagonal, lightly marked.

Distribution

Cultivated but not as extensively as *A. squamosa.*

Uses and properties

The green fruit is stated to give relief in dysentery and to check diarrhoea probably owing to the large amount of tannin in it. Most of the information given under the following species, *A. squamosa,* also holds good in the case of this plant.

Constituents

The trunk-bark contains 0·03 per cent of an alkaloid called anonaine (*2*).

2. Annona squamosa Linn.

Anona squamosa Linn., Fl. Brit. Ind., I, 78.

(Custard Apple, Sweetsop or Sugar Apple of the West Indies and America)

Vernacular names : ARABIC—Saripha, Sharifa ; ASSAM—Ata, Katal ; BENGAL—Ata, Meba, Sitaphal ; BURMA—Auza or Awza ; DECCAN—At, Sitaphul ; GUJERATI—Anan, Anurani, At, Sitaphal ; HINDI—At, Ata-sitaphal, Sharifa, Shariphal, Sitaphal, Sitaphul ; KANARESE—Amritaphala, Duranji, Sitaphala ; KONKANI—At, Ath ; MALAYALAM—Antacheecha, Atta, Attachchakka, Sirpa, Sitapalam, Sutakanni ; MARATHI—At, Sitaphal ; MUNDARI—Borordaru, Neoa, Sampa ; NAGPUR—Neoa ; NEPAL—Shariphal ; PERSIAN—Kaj, Sharifah ; SANSKRIT—Agrimakhya, Atripya, Bahubijaka, Gandagatra, Krishna-bija, Sitaphala, Subha, Suda, Vaidehivallabha ; SANTAL—Mandargom ; TAMIL—Atta, Sitapalam or Sitapazham ; TELUGU—Gandagatramu, Sitapandu, Sitaphalamu ; TULU—Amritakay ; UNITED PROVINCES—Behli, Sharifa ; URIYA—Ata, Sitapholo.

Botanical characters

A tree about 20 ft. high. Leaves $1\frac{1}{2}$–3 by $\frac{3}{4}$–$1\frac{1}{2}$ in., oblong-lanceolate or elliptic, obtuse or subacute, glaucous and pubescent beneath

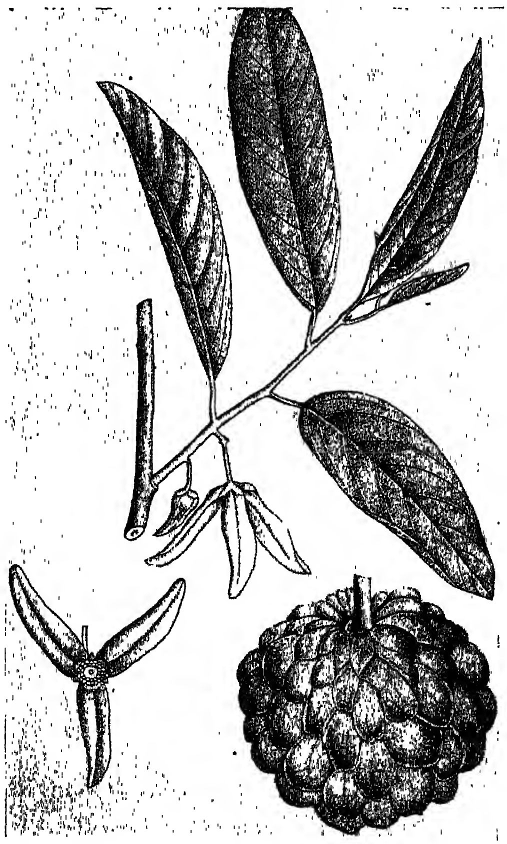

FIG. 14. *Annona squamosa* Linn.

when young ; lateral nerves 8–11 pairs. Flowers solitary, leaf-opposed, or 2–4, on short, extra-axillary branchlets. External petals about 1 by $\frac{1}{4}$ in., the internal minute or sometimes wanting. Fruit globose, 2–4 in. diam., yellowish-green when ripe ; areoles well marked, granulate or tuberculate ; pulp denser than in *A. reticulata* and sweeter.

Distribution

Naturalized in several parts of India ; met with under cultivation and also as an escape.

Toxicity

The roots are regarded as a drastic purgative. The seeds, leaves, and the immature fruits contain an acrid principle fatal to insects ; the dried unripe fruit, powdered and mixed with gram flour, is used for killing vermin and the seeds to kill body lice. Subramaniam (*3*), who has studied the plant recently, states that the powdered seeds and aqueous infusion of leaves have valuable insecticidal properties. The powdered seeds are powerfully irritant to the conjunctiva ; a case has been recorded of a life-convict who, in order to escape from being sent to the Andamans, put the seed powder into his eyes, this destroyed the cornea in both eyes, resulting in total blindness (*4*). When applied to *os uteri*, they are irritant and are said to produce abortion. Pammel (*5*) records the plant as a fish poison.

Constituents

The seeds yield an oil and a resin which contains the acrid principle (*6*). The leaves and seeds have been found to contain an amorphous alkaloid but no glucoside (*7*).

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Family IV.—MENISPERMACEAE

(Moonseed Family)

Botanical characters

Climbing or twining rarely sarmentose shrubs. Leaves alternate, usually palminerved, often peltate; stipules 0. Flowers minute, dioecious, fascicled, panicled or racemose, rarely solitary. Sepals usually 6, in 2 whorls, or 9–12 in 3–4 whorls, rarely fewer, outer often minute. Petals 6 (rarely 0 or 1–5). Male flowers: Stamens usually as many as and opposite to the petals, or anthers connate in a ring round the top of a column, reduced to staminodes or wanting in female flowers. Female flowers: Ovaries 3 (rarely 1, or 6–12). Ripe carpels drupaceous; style-scar subterminal or subbasal. Seed characteristically crescent- or horseshoe-shaped, hence the family name (*menis*—the crescent moon, and *sperma*—a seed).

Distribution

Chiefly tropical.

Economic and toxic aspects

Poisonous, narcotic, and bitter properties of considerable potency are found in plants of this family, especially in their fruits and seeds. A few species are used in medicine on account of the bitter principles contained in them. The leaves of *Cocculus hirsutus* (Linn.) Diels (*C. villosus* DC.), a slender, villosely tomentose climber of tropical and subtropical India, when triturated with water gelatinize it; the juice of its ripe fruit makes a durable bluish-purple ink. The long flexible branches of *Tiliacora acuminata* (Lam.) Miers (*T. racemosa* Colebr.) are used in India for thatching and for making baskets. Some members figure among the poisonous plants used in making arrow and dart poisons. Besides others, which are used by the wild tribes of the Malay Peninsula for this purpose, and which are dealt with in greater detail later, may be mentioned *Tinospora crispa* (Linn.) Diels (*T. crispa* Hook. *f.* & Thoms., *non* Miers); *Cocculus laurifolius* DC. which is found in the subtropical Himalayas from Nepal to Jammu up to an altitude of 5,000 ft., in the Western Ghats of the Madras Presidency and in East Bengal; and the South Indian *Coscinium fenestratum* Colebr. (calumba wood, Ceylon calumba root, columbo wood, false calumba root). The last-mentioned plant contains berberine.

Anamirta cocculus (Linn.) Wight & Arn. (Cocculus indicus of pharmacy) is used for destroying vermin and to poison fish. The berries contain a highly poisonous substance named picrotoxin. *Coscinium fenestratum* Colebr. of South India produces a yellow dye which is

extensively used locally. *Tinospora cordifolia* (DC.) Miers* ('giloe', 'gulancha') is an important medicinal plant in Hindu medicine, and is largely used as an alterative, tonic, and aphrodisiac. The roots of *Stephania glabra* (Roxb.) Miers (*S. rotunda* Hook. *f.* & Thoms., in part, *non* Lour.) of Northern India are acrid.

Jateorhiza palmata (Lam.) Miers (calumba, colombo) is a large scandent undershrub of South-East Africa and is cultivated in some parts of India. The dried roots of the plant, which are used as a simple bitter in Western medicine, contain the alkaloids columbamine, jatrorrhizine, and palmatine (*1*, *2*), closely related to berberine. They also contain two bitter substances, and an essential oil having thymol as its chief constituent.

Constituents

The members of this family have been found to contain: (*a*) *alkaloids*, such as berberine, columbamine, jatrorrhizine, palmatine, stephanine, *epi*stephanine, stephanoline, tetrandrine, etc., (*b*) *saponins*, (*c*) *toxic bitter substances*, such as picrotoxin, and (*d*) other *bitter substances*, such as calumbin, etc.

KEY TO THE GENERA

A. Ovaries 3.
- *a*. Flowers panicled. Filaments connate. Seed globose .. 1. *Anamirta*.
- *b*. Flowers racemose. Filaments free. Seed horseshoe-shaped .. .. 2. *Pachygone*.

B. Ovary 1 .. .. 3. *Stephania*.

1. ANAMIRTA Colebr.

(From artificial Sanskrit *anamrta*, from Sanskrit *an*—not, and *amrta*—elixir of life; referring to its poisonous properties.)

Botanical characters

Shrubs climbing by means of twisted petioles and shoots. Flowers panicled. Sepals 6, with 2 appressed bracts. Petals 0. Male flowers: Anthers sessile on a stout column, bursting transversely. Female flowers: Staminodes 9, clavate. Ovaries 3, on a short gynophore; stigma subcapitate, reflexed. Drupes on a 3-fid gynophore, obliquely ovoid, somewhat compressed, dorsally gibbous; style-scar subbasal; endocarp woody. Seed globose, embracing the subglobose, hollow intrusion of the endocarp; albumen dense, of horny granules.

Distribution

Tropical Asia.

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* Mr. V. Narayanaswami has informed us that some seeds obtained from a *post-mortem* examination of a case of suspected poisoning were sent to the Director, Botanical Survey of India. These were identified as those of *Tinospora cordifolia*. It is possible that the seeds are poisonous, though no work has so far been done to confirm this view.

Anamirta cocculus (Linn.) Wight & Arn.

Fl. Brit. Ind., **I**, 98.

Cocculus indicus of Pharmacy

(Crow Killer, Fishberry, Fish Killer, Indian Berry, Levant Berry, Louseberry, Oriental Berry, Poisonberry)

Vernacular names: ARABIC—Mahijehreh; BENGAL—Kakmari; BOMBAY—Kakamari, Kakaphala, Vatoli; BURMA—Hong; DECCAN—Kakmari; GUJERATI—Jermae, Kakaphula, Kakmari; HINDI—Jermae, Kakmari; KANARESE—Kakamari, Kakkesoppugida; KONKAN—Garudphul, Kadul; MALAYALAM—Anakrytu, Garalaphala, Garaphala, Kantokakomuveli, Kantaka-kunavam, Karantakam, Karanta-katin-kaya, Miunannu, Machattin-kaya, Nanninkuru, Pola, Pollu-kaya, Pullu-kunawam; PERSIAN—Mahijehreh; SANSKRIT—Garalaphala, Kakahva, Kakamari, Kakanashika; TAMIL—Kakkaykollivirai; TELUGU—Kakamari, Kakichempa, Koditige, Tippatige-vittu; TULU—Chipulu; URDU—Mahijehreh; URIYA—Kalabitinai, Kaumari.

Botanical characters

A large climbing shrub. Leaves 4–8 by 3–5 in., subcoriaceous, broadly ovate, cordate or truncate (rarely attenuated) at the base,

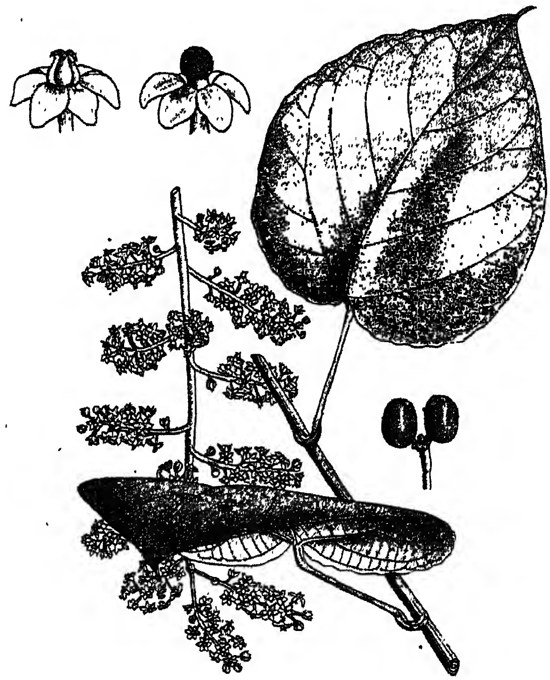

FIG. 15. *Anamirta cocculus* (Linn.) Wight & Arn.

acute or acuminate (rarely obtuse), 5- (rarely 3-) nerved, with a tuft of hairs in the axils of the nerves except the basal ones; petioles thickened

at base and apex. Panicles on old branches, 10–14 in. long; flowers $\frac{1}{4}$ in. diam. Drupes 1–3 (usually 2) on the branches of the enlarged gynophore, $\frac{1}{2}$ in. diam., smooth, black.

Distribution

Found in Assam, Eastern Bengal, Oudh, Orissa, and Konkan southwards to Ceylon.

Uses and properties

The fruits of this plant are highly poisonous and are used in India to poison fish and crows, and rarely for poisoning cattle; the flesh of fish so poisoned also becomes poisonous. A kind of ointment prepared from the drupes is employed as an insecticide. The jungle tribes of Malay Peninsula use the plant to poison their 'kris' and arrows. A decoction or extract of the drupes has been used in England as an adulterant of beer for increasing its intoxicating power. It is also said to be used for the same purpose by liquor retailers in the Bombay Presidency where it has given rise to cases of poisoning. Wharten and Stille, quoted by Waddell (*3*), record 6 cases of accidental poisoning by a decoction of fruits; two died within half an hour but the remaining four recovered after several hours. An ointment (2 per cent) and tincture (full strength) are sometimes used against pediculi, but this practice is dangerous and they should be used with caution; they should never be applied to abraded skin.

Constituents

The fruit owes its activity to the presence of picrotoxin, a crystallizable nonalkaloidal compound of definite chemical composition contained in the seeds, but not in the pericarp. In fact the pericarp is non-poisonous, and an entire drupe might, therefore, pass through the body without producing untoward symptoms (*3*). Picrotoxin is present in the seed to the extent of about 1·5 per cent (*4*).

A product consisting of picrotoxin, anamirtin and picrotin, obtained from this plant by Barth and Kretschy, was wrongly named as "picrotoxin"; this mixture must really be regarded as "picrotoxinin" which is readily obtained from picrotoxin by the action of hydrochloric acid (*2*). All these substances have identical actions, but the activity of picrotoxinin is very much greater.

Two alkaloids namely menispermine and paramenispermine have also been isolated from the drupes. Both these alkaloids are physiologically inactive (*5*).

Poisoning with picrotoxin

The symptoms of picrotoxin poisoning are very similar in all classes of vertebrates. In man, cerebral symptoms may be most prominent, consisting firstly of restlessness and later unconsciousness; convulsions do not appear until a short time before death. Vomiting is not infrequently observed. The first symptoms may be salivation, acceleration of respiration and slowing and sometimes palpitation of

the heart; stupor and unconsciousness follow and then occur a series of powerful convulsions of clonic type, principally affecting the extremities, which are alternately extended and flexed in contrast to the tonic contractions of tetanus. Respiration is interrupted during the spasms but returns to normal during the intervals of quiet and collapse which follow them. Convulsions return after a short pause and this alternation of spasm and quiet may continue for some time, although respiration often fails to return after one of the spasms and fatal asphyxia results.

The clonic convulsions of picrotoxin poisoning are different from those of strychnine and other similar substances which induce prolonged tonic convulsions, and it was early surmised that the members of this series act on a different part of the central nervous system. As a result of experiments on fishes, amphibia and mammals, it appears that the seat of action tends to move upwards as the higher parts of the central nervous system are more developed; the main action in the frog is on the spinal cord, medulla and optic lobes, and on the cerebrum and midbrain in mammals. It is possible that the cerebrum in man is more affected than in the lower mammals.

The action of picrotoxin is confined to the central nervous system and nothing is known either of its distribution or fate in the body. The poison disappears rapidly during putrefaction (within one to two weeks), and toxicologic analysis must, therefore, be done promptly.

Post-mortem appearance

Post-mortem appearance is not characteristic. Congestion of the stomach, lungs, and brain is present. There may be peritonitis in cases of delayed death.

Treatment

In cases of poisoning, the stomach should be emptied by an emetic or by a stomach tube, and medicinal charcoal finely suspended in water should be given. For convulsions, potassium bromide and chloral hydrate are indicated.

2. PACHYGONE Miers

(Etymology obscure.)

Botanical characters

Climbing shrubs. Flowers in axillary racemes, dioecious. Sepals 6, 2-seriate, outer smaller. Petals 6, much smaller, base auricled and embracing the filaments. Male flowers: Stamens 6, free; filaments incurved; anthers bursting transversely. Female flowers: Staminodes 6. Ovaries 3; styles stout, horizontal. Drupes reniform, style-scar subbasal; endocarp reniform, rugulose. Seed horseshoe-shaped, exalbuminous.

Distribution

Indo-Malayan.

Pachygone ovata (Poir.) Miers *ex* Hook. *f.* & Thoms.

Fl. Brit. Ind., I, 105.

Vernacular names : BURMA—Ngupyu ; TAMIL—Kadukkodi.

Botanical characters

A lofty climber with tomentose branches. Leaves $1\frac{1}{2}$–2 by $\frac{3}{4}$–$1\frac{1}{4}$ in., coriaceous, ovate-oblong or subtrapezoid, obtuse, retuse or mucro-

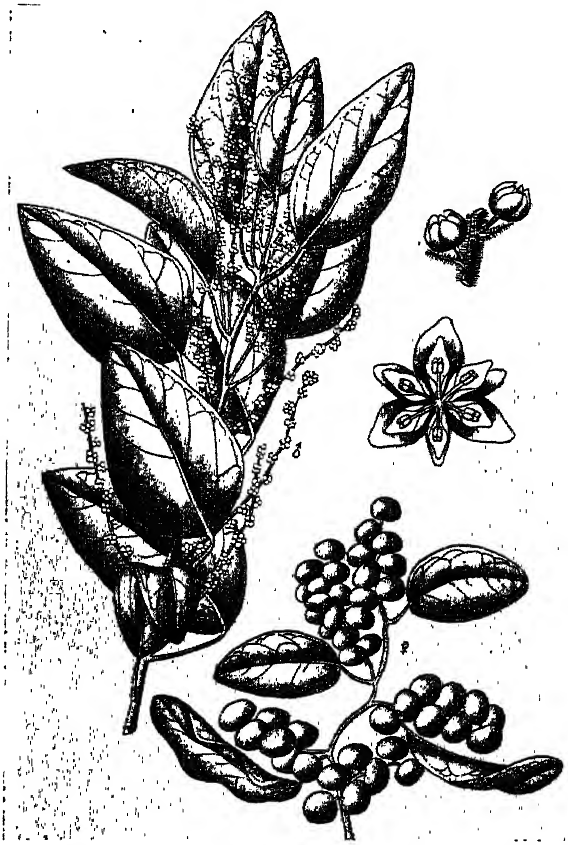

FIG. 16. *Pachygone ovata* (Poir.) Miers *ex* Hook. *f.* & Thoms.

nate, base cuneate or rounded, 3–5-nerved, glabrous ; petiole with a basal ring of hairs. Male racemes exceeding the leaves. Flowers minute, white, honey-scented. Drupes pea-shaped, $\frac{1}{3}$ in.

Distribution

Found on the sandy seashore of the Coromandel Coast from Nellore to Tanjore and Tinnevelly; also in the Deccan in Bellary, Cuddapah, and Mysore.

Toxicity

The dried fruit is used for destroying vermin and stupefying fish. Pammel (*6*) also records it as a fish poison.

3. STEPHANIA Lour.

(From the Greek *stephanos*—a crown; referring to the ring of anthers on the top of the staminal column.)

Botanical characters

Climbing shrubs. Leaves usually peltate. Flowers small, in compound cymose umbels. Male flowers: Sepals 6–10, free. Petals 3–5, shorter than the sepals, fleshy. Anthers 6, connate into a ring round the top of the staminal column, bursting transversely. Female flowers: Sepals 3–5. Petals as in the male. Staminodes 0. Ovary 1; style 3–6-partite. Drupe glabrous; endocarp compressed, horse-shoe-shaped, dorsally tubercled, sides hollow and perforate. Seeds almost annular.

Distribution

Tropics of the Old World and Australia.

Constituents

A foreign species, *S. japonica* (Thunb.) Miers, contains metaphanine and several other alkaloids (*1*).

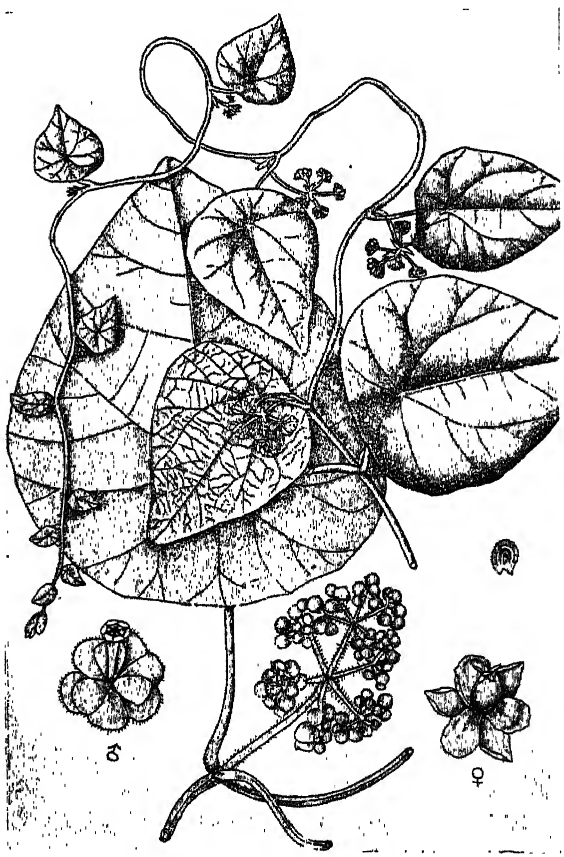

FIG. 17. *Stephania hernandiifolia* (Willd.) Walp.

Stephania hernandiifolia (Willd.) Walp.

S. hernandifolia Walp., Fl. Brit. Ind., **I**, 103, in part.

Vernacular names: BENGAL—Agnad, Agnad-nemuka, Akanadi, Nemuka; BURMA—Sha-ma-say-nway; HINDI—Akanadi; MALAYALAM—Patakilannu, Patavalli; NEPAL—Tambarki; SANSKRIT—Ambashtha, Patha, Vanatik-tika; URIYA—Musakani, Nimukha, Okanobhindi, Sondhimali.

Botanical characters

A slender twining shrub with striate branchlets and glabrous young shoots. Leaves 3–5 by 2½–4 in., thinly coriaceous, peltate, ovate or subdeltoid, acute, acuminate, or subobtuse, mucronate, rounded or truncate at the base. Flowers minute, nearly sessile, in small umbels at the ends of long-stalked axillary umbels. Peduncles about 1 in. long, glabrous; rays 5–12. Drupes solitary, subsessile, ⅓ in. long, obovoid, compressed, glabrous; endocarp deeply and sharply transversely ridged. Seed curved almost into a ring.

Distribution

Found on the West and East Coast, Dehra Dun, Bihar, Cachar, Sikkim, East Bengal, and Assam.

Uses and properties

This plant is used in the treatment of diarrhoea, dyspepsia, and urinary diseases. Its extract acts as a strong poison on frogs (*7*). It probably contains some saponins (*8*).

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Family V.—BERBERIDACEAE

(Barberry Family)

Botanical characters

Glabrous herbs or shrubs, sometimes climbing. Leaves simple or compound, alternate or tufted on dwarf shoots, rarely stipulate. Flowers often globose, usually yellow or white. Sepals (often petaloid) and petals free, caducous, usually trimerous and biseriate. Stamens 3–8, usually 6, opposite the petals, free or connate; anthers opening by two apical valves or longitudinally. Carpels 1–3, rarely more, free; style short or 0; stigma large. Fruit of berries or capsules, usually indehiscent. Seeds with copious albumen.

Distribution

Chiefly in temperate and mountainous regions.

Economic and toxic aspects

The roots and barks of plants belonging to this family generally have purgative properties. Several species of *Berberis* are used medicinally as bitter tonics and mild laxatives. Some plants of this genus are found to contain an alkaloid named berberine, which is not very toxic; some others have the alkaloids berbamine and oxyacanthine. Berberine is also found in *Mahonia napaulensis* DC. (*Berberis nepalensis* Spreng.) and in some plants belonging to other families, *e.g.*, *Argemone mexicana* Linn. (Papaveraceae), *Coptis teeta* Wall. (Ranunculaceae), *Coscinium fenestratum* Colebr. (Menispermaceae), and *Toddalia asiatica* (Linn.) Lam.,—syn. *T. aculeata* Pers.,—(Rutaceae). The roots of *Berberis aristata* DC. are stated to be used as a fish poison. The resin from the species of *Podophyllum* is used in medicine as a drastic but slowly acting purgative. *Caulophyllum thalictroides* Michx., a foreign plant, is extremely bitter to taste and contains saponins.

An interesting point about some species of *Berberis* is their connection with the disease known as black rust, which is a destructive parasite of wheat and other cereals. The fungus (*Puccinia graminis* Pers.) passes through two alternate stages in its life cycle, one on a cereal and the other on a barberry, so that if barberries are absent in an area, the cereals are to a large extent, though by no means absolutely, insured against black rust. In India, however, though the black rust is very common and causes considerable economic loss, barberries are of no importance in its life cycle.

Constituents

Members of this family have been found to contain: (*a*) *alkaloids*, such as berbamine, berberine, oxyacanthine, palmatine, hydrastine,

shobakunine, etc., (*b*) *resins*, such as podophyllin having components like podophyllotoxin, picropodophyllin, etc., and (*c*) *saponins*, such as caulosaponin, caulophyllosaponin, etc.

KEY TO THE GENERA

a. Shrubs.	Flowers small, yellow	1. *Berberis.*
b. Herbs.	Flowers large, white or pink	2. *Podophyllum.*

1. BERBERIS (Tourn.) Linn.

(From *barbaris*, its Arabic name.)

Botanical characters

Spiny shrubs with yellow wood. Leaves alternate or clustered on dwarf shoots in the axil of a 1–3–5-branched spine, simple, entire or more often spiny-toothed. Flowers small, yellow, solitary, fascicled or racemed, with 2–3 appressed bracts. Sepals 6, in two whorls. Petals 6, in two whorls, 2-glandular at the base. Stamens 6, free; anthers dehiscing by valves. Carpel 1. Fruit a blue or red berry, few-seeded.

Distribution

In Northern Hemisphere and South America.

Economic and toxic aspects

About 40 species of the genus are used medicinally and seem to have similar therapeutic properties. Their stems and barks are used as bitter tonics and mild laxatives.

According to Pammel (1), the berries of trailing mahonia (*B. aquifolium* Pursh, syn. *B. repens* Lindl.) of America are injurious to birds and, when eaten fresh, act as an emetic and cathartic. Berries of *B. aristata* DC., *B. asiatica* Roxb. *ex* DC., and *B. lycium* Royle are, however, eaten by birds and man in India. *B. aristata* has been reported to be poisonous to fishes and it is possible that a few more species may have similar properties.

A yellow dye obtained from the roots and stems of some of the species is of great value in tanning and for colouring leather. An extract prepared from the roots of *B. aristata*, *B. asiatica* and *B. lycium*, known under the name of 'rasaut', is a highly esteemed drug in indigenous medicine and is used as a stomachic, febrifuge, bitter tonic, mild laxative, for eye diseases and for haemorrhoids both locally and internally.

Constituents

Berberine is the best known alkaloid of the genus although berbamine, oxyacanthine, palmatine, hydrastine, jatrorrhizine, columbamine, shobakunine, etc., are also reported from the root-barks.

Action of berberine

Berberine is an intensely yellow and bitter alkaloid. It is not toxic in the ordinary sense to large animals and man. Sixty grains have been

taken by man with impunity though it is poisonous to dogs and some other animals (*2*). The minimum lethal dose for frogs and rats is 0·1 mgm and 0·25 mgm per gm of body weight, whereas it is 0·1 mgm per gm of body weight for rabbits when given subcutaneously. The alkaloid is readily absorbed from the gastro-intestinal tract and by subcutaneous and intramuscular routes. It has little or no effect on the automatic movements of the gastro-intestinal tract when introduced into the lumen of the gut. Intravenous injections produce a momentary increase in the tone and peristaltic movements of the gut. It has a depressant action on the cardio-vascular system and produces a sharp and persistent fall of blood pressure; the vasomotor centre is depressed. The respiratory centre is very susceptible to the drug; small doses stimulate and produce acceleration of the respiratory movements, while with larger doses there is initial stimulation followed by depression. Very large doses produce death by paralyzing respiration; the heart, however, goes on beating long after respiration stops.

This alkaloid has no effect on malarial parasites, but is remarkably efficacious against the parasite of Oriental sore (*Leishmania tropica*), the growth in cultures being inhibited in dilutions of 1 in 80,000. One-third of a grain (0·02 gm) dissolved in 1·5 c.c. of distilled water injected at the base of an Oriental sore (*3*), produces a cure in most cases.

Berberis aristata DC.

B. aristata, var. *floribunda* Hook. *f.* & Thoms., Fl. Brit. Ind., I, 110; *B. coriaria* Royle *ex* Lindl., Bot. Reg., 1841, **27**, *t.* 46.

(Indian Barberry, Tanner's Barberry)

Vernacular names: ARABIC—Aargis, Ambarbaris; BHUTIA—Teema; GARHWAL—Kingora; HINDI—Chitra, Chotra, Darhald, Kashmal, Kashmar, Rasvat; JAUNSAR—Kashmoi; KANARESE—Bagisutra; MALAYALAM—Maradarisina, Maramanjal; NEPAL—Chitra, Chutro; PERSIAN—Chitra, Zarishk: PUNJAB—Chitra, Kasmal, Simlu, Sumblu, Sumlu; SANSKRIT—Daruharidra, Darvi, Kata, Katankati, Kateri, Pitadaru, Suvarnavarna; SIMLA—Kammul, Kashmal, Kaumul; UNITED PROVINCES—Chitra.

Botanical characters

A robust shrub 8–10 ft. high; basal spines tripartite, upper simple. Leaves $1\frac{1}{2}$–3 by $\frac{3}{5}$–$1\frac{1}{5}$ in., obovate or elliptic, deciduous, rarely petiolate, entire or spiny-serrate, glabrous, green on both sides. Racemes simple, about as long as the leaves, spreading; pedicels stout. Fruit blue, ovoid; style short, thick, capitate.—Young fruits whitish.

Distribution

Found in the North-Western Himalayas in open shrubby places from Chota Banghal to Nepal at altitudes of 6,000 to 10,000 ft.; not common west of the Sutlej.

This plant is stated by Pammel (*1*) to be a fish poison. *Toxicity*

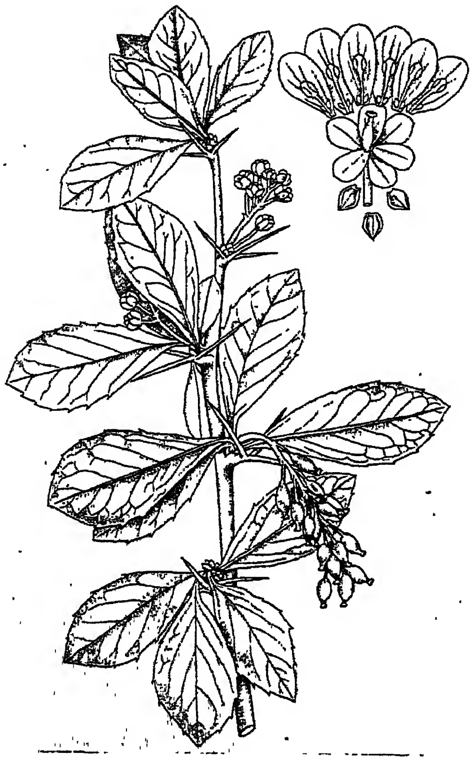

FIG. 18. *Berberis aristata* DC.

2. PODOPHYLLUM Linn.

(From the Greek *pous, podos*—a foot, and *phyllon*—a leaf; referring to the shape of the leaves, which bear some resemblance to a duck's foot.)

Botanical characters

Scapigerous herbs; rootstock creeping, scaly, 2-leaved. Leaves peltate, palmately lobed. Flowers large, white or pink. Sepals 3–6, petaloid. Petals 6–9 (rarely 4). Stamens as many or twice as many as the petals. Ovary simple; stigma large, sessile, peltate. Fruit berried, many-seeded. Seeds obovoid, embedded in pulp.

Distribution

A North American and a Himalayan species.

Constituents

The active constituents in the resins of plants of this genus consist of podophyllotoxin, picropodophyllin, podophyllinic acid, etc,

Podophyllum hexandrum Royle

P. emodi Wall. *ex* Hook. *f.* & Thoms., Fl. Brit. Ind., I, 112.

(Duck's-foot, Indian May Apple)

Vernacular names: GUJERAT—Venivel; HINDI—Bakra-chimyaka, Bhavan-bakra, Papra, Papri, Nibishi, Pilijati; KASHMIR—Ban-waingan; MARATHI—Padwel, Patvel; PUNJAB—Ban-bakri, Ban-kakra, Ban-kakri, Chijakri, Chimyaka, Chyakri, Gulkakru, Kakra, Papri, Wan-waingan.

Botanical characters

A glabrous, succulent, erect herb. Scape 6–18 in., leafy at the top. Leaves 2, often purple-spotted, 6–10 in. across, 3–5-lobed to the

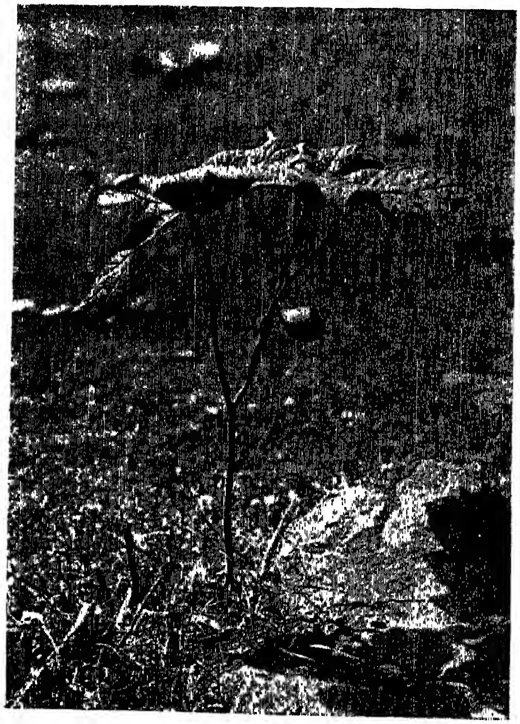

FIG. 19. *Podophyllum hexandrum* Royle

middle or base, sharply toothed. Flowers solitary, rarely 2, cup-shaped, 1–1½ in. diam., white, sometimes pink. Sepals 3, soon falling off. Petals 6. Stamens 6. Berry ovoid, 1–2 in., scarlet.

Distribution

Found in the interior ranges of the Himalayas at altitudes of 9,000 to 14,000 ft. from Sikkim to Hazara, descending to 6,000 ft. in Kashmir.

Uses

The rootstock of this plant contains the podophyllum resin which is used as a cholagogue purgative.

Constituents

The average yield of the resin (podophyllin) and of crystallized podophyllotoxin (the active constituent of podophyllin) from the rhizome of *P. hexandrum* has been found to be 10 per cent and 3·5 per cent respectively. The amount of podophyllotoxin in the resin podophyllin from the Indian drug is about 38 per cent, whilst that in the American podophyllin (from *P. peltatum* Linn.) is about 20 per cent. Although there is a difference of nearly 20 per cent in the amount of podophyllotoxin contained in the podophyllin from these two sources, it is remarkable that they differ little in their physiological activity (*4*, *5*).

Action

Podophyllin greatly irritates the eyes and the mucous membranes generally. The resin does not affect the unbroken skin but may be absorbed from raw surfaces and give rise to purging. It is an active purgative and is administered in average doses of 0·01 gm; in toxic doses it produces intense enteritis which may result in death (*6*).

Podwyssotski (*7*) attributed the laxative action of the drug solely to podophyllotoxin. In crystalline form it is intensely toxic to dogs and cats; 0·005 gm injected subcutaneously killed a cat. With subcutaneous injection the following symptoms were observed by him in dogs: effects on the nervous system became manifest very soon after injection, with disturbances of co-ordination in the posterior extremities; rapidly increasing weakness became noticeable, which, however, was not always in direct relation to the violence of gastro-intestinal symptoms; respiration was greatly hurried and there was a great lowering of temperature; death usually occurred with the animal in a comatose state. Several violent clonic cramps were also observed before the termination of life.

Post-mortem appearance

Post mortem, the mucous membrane of the stomach is reddened; the intestines are generally strongly contracted, but their mucous membrane is less hyperaemic; the liver is dark and full of blood and the gall bladder is frequently distended.

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Family VI.—PAPAVERACEAE

(Poppy Family)

Botanical characters

Herbs with milky, often coloured juice. Leaves radical or alternate, exstipulate. Flowers often showy, regular. Sepals 2 (or 3), caducous. Petals 4–6, biseriate, caducous. Stamens indefinite, caducous. Ovary 1-celled, with 2-several parietal, often lamelliform placentas and many ovules; style short or 0; stigmas radiating, connate or free. Fruit capsular, dehiscing by valves or pores. Seeds many, small; albumen fleshy and oily.

Distribution

Chiefly in north temperate zone.

Economic and toxic aspects

Quite a number of the members of this family possess medicinal and poisonous properties; some have sedative, narcotic, and stupefying properties and at times are caustic and rubefacient. The seeds are generally oleaginous and in some cases emetic and cathartic. The most important representative of this family is *Papaver somniferum* Linn., which is the source of the well-known drug opium. This plant is often grown for ornamental purposes; its seeds are used for culinary purposes and also fed to birds. Opium, the inspissated juice obtained from the unripe capsules, yields a large number of alkaloids of which morphine and codeine are the best known. The petals of the red poppy (*P. rhoeas* Linn.) contain a colouring matter.

P. argemone Linn. (rough-headed poppy), with pale-scarlet flowers and with the capsules sparingly beset with weak straight bristles, is commonly cultivated in Indian gardens. *P. orientale* Linn. is another garden plant with scarlet flowers; it has been found to contain alkaloids, such as thebaine, *iso*thebaine, protopine, glaucidine, etc. *Eschscholtzia californica* Cham. (Californian poppy), with yellow, orange or cream-coloured flowers, is frequently grown as a cold-weather annual in the plains.

The seeds of the Mexican poppy (*Argemone mexicana* Linn.) yield an oil which is occasionally found as an adulterant of mustard oil in India. The adulterated oil produces a condition which is clinically indistinguishable from the disease called epidemic dropsy. This herb has been found to contain two alkaloids, berberine and protopine; the seeds also contain these alkaloids.

Constituents

The members of this family contain: (*a*) *toxic alkaloids*, such as morphine, codeine, narcotine, thebaine, papaverine, laudanine, laudani-

dine, laudanosine, protopine, cryptopine, narceine, chelidonine, homochelidonine, sanguinarine, etc., (*b*) *comparatively inactive alkaloids*, such as berberine, rhoeadine, etc., (*c*) *purgative oils*, such as argemone oil, and (*d*) *hydrocyanic acid*.

KEY TO THE GENERA*

a. Stigmas 4–7, radiating from the top of a depressed style .. 1. *Argemone*.
b. Stigmas 4–6, decurrent on the top of the style .. 2. *Meconopsis*.
c. Stigmas 4 or more, radiating on a sessile disc .. 3. *Papaver*.

1. ARGEMONE Tourn. *ex* Linn.

(From the Greek *argema*—a cataract in the eye; the juice of the plant was used as a remedy in diseases of the eye.)

Botanical characters

Erect glaucous prickly herbs, with yellow juice. Flowers handsome, terminal. Sepals 2–3. Petals 4–6. Stigma 4–7-lobed on a very short style. Capsule oblong, dehiscing at top by short valves alternating with the stigmas.

Distribution

American plants; of these, *A. mexicana* Linn. has been naturalized in India.

Argemone mexicana Linn.

Fl. Brit. Ind., I, 117.

(Mexican Poppy, Prickly Poppy, Yellow Mexican Poppy, Yellow Poppy)

Vernacular names: BENGAL—Shialkanta, Sialkanta; BURMA—Khyaa; DECCAN—Bharamdandi, Daruri, Farangi-dhatura, Pila, Pila-dhatura; HINDI—Bharbhand, Bila-dhutura, Brahmadundi, Brahmi, Farangi-dhutura, Pila-dhutura, Satiyanashi, Shialkanta, Suchianas, Ujarkanta; KANARESE—Balurakkisa, Datturi, Mullu-daturi, Parangi-datturi; KATHIAWAR—Darudi; KONKANI—Firingi-dutro, Redonoxi; MALAYALAM—Brahmadanti; MARATHI—Daruri, Firangi-dhotra, Kante-dhotra, Konte-dhotra, Pinvala-dhotra; MUNDARI—Bakula-janum; PUNJAB—Bhatkateya, Bhatmil, Bherband, Kandiari, Kateli, Katki, Katoi, Satyanasa, Sialkanta; SANSKRIT—Brahmadandi; SANTAL—Gokhula-janum; TAMIL—Pirama-dandu, Kurukkum, Kurukkumkedi; TELUGU—Brahmadandi; UNITED PROVINCES—Bharbhurva, Ghamoi, Kantela, Karvah; URDU—Baramdamdi; URIYA—Kanta-kusham, Odissimari, Sarpuni.

Botanical characters

A robust prickly herbaceous annual 1–4 ft. high, with spreading branches. Leaves thistle-like, 3–7 in., sessile, ½-amplexicaul, sinuate-pinnatifid, variegated green and white. Flowers 1–3 in. across, yellow. Sepals horned at the top, prickly. Capsule ¾–1½ in. long, elliptic or oblong, prickly. Seeds blackish-brown, round, netted.

* *Sanguinaria canadensis* Linn., a foreign plant, whose roots are used in medicine, is also discussed in the text.

Distribution

It is an American plant which has become completely naturalized in India and grows wild all over the country in wastelands and along roadsides.

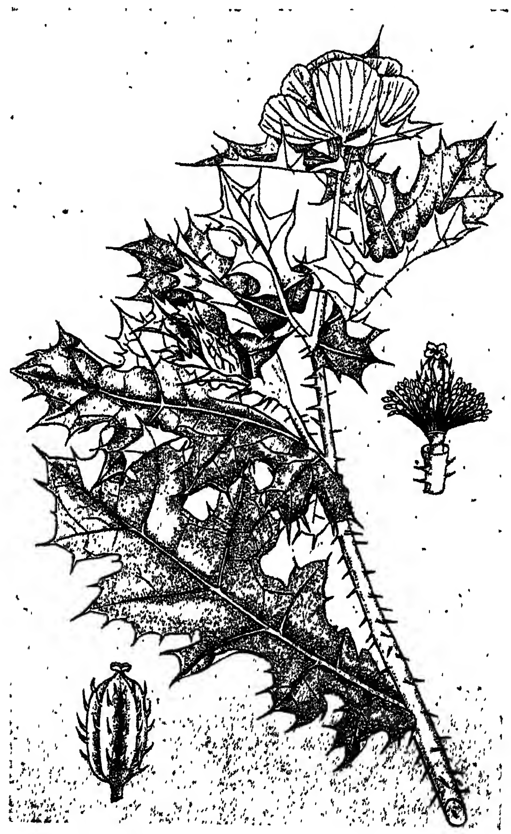

FIG. 20. *Argemone mexicana* Linn.

Uses and properties

This plant is used medicinally in several countries. The yellow juice is used in the treatment of dropsy, jaundice, and cutaneous affections. Its use as a cure for eye diseases, although interesting historically (*see* etymology), seems to be dangerous. The seeds, which bear a superficial resemblance to black-mustard seeds, are stated by many authors to possess narcotic properties. Moodeen Sheriff, however, claims that even in doses of two drachms and a half they are not narcotic (*1*). On expression they yield a pale-yellow clear limpid oil to the extent of about 36 per cent which is used for lighting and medicinally for application to ulcers and eruptions. This oil, which is known as 'kaṭakar' oil in some

parts of India, or the argemone oil, has also been employed as an aperient by medical practitioners in the West Indies. According to Baden Powell (*1*), it is supposed to be *fico del inferno* of the Spaniards who consider the seeds more narcotic than opium. In larger doses the oil acts as an irritant, giving rise to vomiting and purging.

Poisoning

Sarkar (*2*) described symptoms closely resembling those of epidemic dropsy, which occurred in a group of persons who took mustard oil adulterated with 'katakar' oil. These consisted of spitting and vomiting with diarrhoea, followed by oedema of the feet and legs. There was intense pain all over the body; the oedematous area in the legs and feet subsequently became inflamed while a certain amount of solid oedema persisted in the legs and feet for a considerable time.

During the course of work on the aetiology of epidemic dropsy at the Calcutta School of Tropical Medicine and the All India Institute of Hygiene, it was found that argemone oil was present in mustard oils incriminated in the outbreaks of this disease in many places. The amount of oil present in the implicated mustard oils was estimated (colorimetrically) to be about 5–10 per cent. The test for this oil is simple, and consists in adding nitric acid to the oil in a test tube. The tube is shaken and a positive reaction is shown by the development of a brown to an orange-red colour in the nitric acid.

Relationship to epidemic dropsy

Since epidemic dropsy could not be reproduced in animals, the effect of mustard oil adulterated with argemone oil was tested on human volunteers. Argemone oil was mixed in proportions of 2–10 per cent with mustard oil, and two ounces of the mixture were used for cooking the daily food of each of the five volunteers. All the five individuals developed symptoms clinically indistinguishable from those of epidemic dropsy. It appears that the principle or principles found in the argemone oil have a cumulative effect, and, provided sufficient quantity of the oil is consumed, symptoms appear after an interval even though the consumption of the oil is stopped. This fact must be borne in mind in all investigations of mustard oils in outbreaks of the disease (*3*).

A portion of skin removed from one of the individuals who took the food cooked in mustard oil containing argemone oil and who developed flush and oedema showed marked dilatation of the capillaries as was observed in typical cases of naturally occurring epidemic dropsy. It may be noted, however, that some of the symptoms which frequently occur in this disease, *e.g.*, glaucoma and sarcoids, were not produced in these volunteers.

Feeding experiments with animals in the laboratory have shown the expressed argemone oil to be definitely toxic to monkeys, cats, guinea pigs, and mice. Monkeys and cats developed somnolence and diarrhoea culminating in death ; guinea pigs and mice lost weight and died without showing any symptoms. The oil heated to 240°C for 15 minutes lost its toxic properties.

Oil as adulterant

From the very wide distribution of the plant it is likely that some of the argemone seeds get mixed up with mustard seeds and are occasionally responsible for the adulteration of the commonly used mustard oil in some parts of India. Circumstantial evidence, however, strongly indicates that in a number of cases at least this adulteration is intentional. The plant is very common throughout India and the oil obtained from the seeds is cheap. Further field and laboratory investigations, however, are in progress.

Constituents

The plant devoid of seeds contains the alkaloids berberine and protopine (*4*). Dragendorff found the seeds to contain an alkaloid which gave reactions closely resembling those of morphine (*5*), but this plant has been shown to contain no morphine (*6*). The presence of traces of alkaloids in the expressed oil reported by earlier workers has recently been confirmed by the present authors.

Protopine was first isolated from opium but has since been found in a number of papaveraceous plants. It shares the depressant action of morphine on the heart (*7*), and is also said to paralyze the sensory nerve endings in the same way as cocaine. In small doses protopine acts on frogs as a narcotic and in larger doses paralyzes the muscle and peripheral nerve endings. In mammals it has a poisonous action resembling that of camphor, but differs from that of the latter in that it has the effect of paralyzing the circulatory organs (*8*).

2. MECONOPSIS Vig.

(From the Greek *mekon*—a poppy, and *opsis*—appearance.)

Botanical characters

Perennial herbs; juice yellow. Leaves entire or lobed. Flowers large, blue, yellow or purple, solitary or in racemose cymes or paniculate. Sepals 2. Petals usually 4. Style mostly distinct, stigmatic lobes radiating on its clubbed extremity. Capsule ovoid or elongate, with short valves below the persistent style. Seeds rugose.

Distribution

Mountains of the Northern Hemisphere.

Toxic aspects

Members of this genus are reputed to possess powerful narcotic and poisonous properties. The leaves of an American species, *M. cambrica* (Linn.) Vig., are known to yield hydrocyanic acid (*9*).

KEY TO THE SPECIES

a. Radical leaves remotely and irregularly pinnatifid-lobate. Capsule broadly obconical, oblong or obovate .. 1. *M. aculeata*.

b. Radical leaves pinnatipartite. Capsule subcylindric or narrowly ovate .. .. 2. *M. napaulensis*.

1. Meconopsis aculeata Royle

Fl. Brit. Ind., I, 118.

(Blue Poppy)

Vernacular names: JHELUM—Guddikum; KUMAON—Kanda; RAVI—Gudi, Gudia; SIMLA—Kanta; SUTLEJ—Kanada.

Botanical characters

A subglaucous herb 1–2 ft. high, with short, scattered prickles. Radical leaves linear-oblong, remotely and irregularly pinnatifid-lobate, long-petioled, 4–8 in. long including the petiole; cauline

FIG. 21. *Meconopsis aculeata* Royle.

shorter-petioled or sessile. Flowers $1\frac{3}{5}$–$2\frac{4}{5}$ in. diam., purplish-blue or greyish steel-blue, forming racemose cymes. Sepals glabrous, aculeate. Capsule broadly obconical, oblong or obovate, setose-echinate; style half as long.

Distribution

Usually found among stony places in the Western Himalayas from Kashmir to Kumaon, at altitudes of 10,000 to 15,000 ft.

Toxicity

The root is known in Kashmir as a narcotic, and in Chamba it is regarded as poisonous. O'Shaughnessy, however, gave a drachm of an alcoholic extract of the plant to a dog without producing any perceptible effect (*1*). Chemical examination did not show the presence of any alkaloid (*10*).

2. Meconopsis napaulensis DC.

M. wallichii Hook., var. *fusco-purpurea* Hook. *f.*, Bot. Mag., 1884, **40**, t. 6760.

Botanical characters

A glaucescent herb, laxly hairy and rarely substellately pubescent; stem 2–5 ft. high, stout. Basal leaves pinnatipartite, stem-leaves pinnatifid or lyrate-pinnatisect, upper ones sessile. Flowers $2\frac{2}{5}$–$3\frac{1}{5}$ in. diam., obscurely fuscous-purple or pale-blue, in simple or paniculate cymes, nodding. Sepals laxly strigose and densely stellate-tomentose. Capsule subcylindric or narrowly ovate, first with yellow appressed bristles, then densely covered with reddish spreading or reflexed hairs; style about as long.—Closely related to *M. wallichii* Hook. of the Eastern Himalayas.

Distribution

Found in the temperate Himalayas at altitudes of 10,000 to 12,000 ft. in Sikkim, Nepal, and Bhutan.

Toxicity

The roots are stated to have narcotic properties.

3. PAPAVER Tourn. *ex* Linn.

(The classical Latin name of the poppy; etymology obscure.)

Botanical characters

Annual or perennial herbs with milky juice. Leaves lobed or cut, not prickly. Flowers on long peduncles. Stigmas sessile, connate, radiating, peltate or pyramidal, with many short free lobes. Capsule short, opening by small valves under the persistent stigma-lobes. Seeds pitted.

Distribution

In Europe, Asia, America, South Africa, and Australia.

Toxic aspects

The flowers and fruits are sedative and the milky juice is narcotic, sometimes caustic. Most of the species yield some or other of the alkaloids of opium to a greater or lesser extent. *P. somniferum* Linn. is, however, the commercial source of opium, which is the inspissated latex of the unripe fruit of this plant.

Opium owes its activity to a large number of alkaloids of which morphine, codeine, papaverine, narcotine, and thebaine are important. The total alkaloids in opium vary from about 5 to 25 per cent and different specimens may contain very different quantities of each alkaloid. The average percentage of morphine may be as high as 10, narcotine 6, papaverine 1, codeine 0·5, thebaine 0·3, and narceine 0·2; the others occur in too small quantities to have much influence on the action of the crude drug. The action of opium is mainly due to the large amount of morphine contained in it, although the presence of other alkaloids may modify or potentiate its effects. The action of morphine may, therefore, be described as representing that of the whole drug. *Opium*

When morphine is taken by mouth it is readily absorbed mainly from the small intestines, but partly from the stomach. It has a specific action on the nerve cells of the brain, particularly the sensory cells of the cortex, the action being mainly depressant. Morphine appears to lessen the power of attention and under its influence the individual remains unconscious of any constant stimulus. Thus, while constant pain is alleviated, a sudden shock causes as much pain as if no morphine had been taken. This specific action on pain indicates that morphine is specially endowed with the power of depressing the paths by which pain stimuli reach the brain. The motor area of the cortex is not affected by small doses of morphine, but larger doses lower and eventually abolish its excitability. *Action of morphine*

In animals the symptoms of morphine poisoning present an extraordinary mixture of stimulation and depression, and the relative prominence of these varies widely in different species. The motor cells of the spinal cord are at first slightly stimulated but soon depressed.

Morphine in its action on the nervous system illustrates the well-known fact that functions at first stimulated by a drug are usually paralyzed by it in the end. It affords an excellent example of the law of dissolution. Higher functions, such as the intellectual and imaginative, are first affected, motion is then disordered, and next the pupillary centre and then the medullary centres for respiration and cardiac actions are implicated. The spinal cord is influenced to a lesser degree, the nerves very slightly, and the muscles not at all.

In man and in most animals respiration is slowed by morphine. It has little direct action on circulation in man. In dogs the heart is slowed and becomes irregular from powerful stimulation of the vagus. In cats the slowing of heart is inconstant, while in rabbits it is only produced by comparatively large doses. The effects of morphine on the alimentary canal also vary with the species of animal. In man

morphine induces constipation, and in most animals small quantities have the same effect. In some animals, however, it produces diarrhoea.

Morphine lowers the basal metabolism sometimes by as much as 25 per cent, soon after an injection. After repeated doses, however, this effect is no longer observed.

Morphine is excreted into the stomach to the extent of nearly half of the amount taken. Small amounts of the alkaloid are also excreted with urine, sweat, and mammary secretion. In chronic morphinism destruction of morphine doubtless takes place to some extent in the body, but there is in addition a very considerable storage of the drug in the muscles and in the liver.

Codeine

Codeine resembles morphine in its general action in man, but is much weaker. In animals the symptoms of excitation are more obvious, especially in the spinal cord, and may give rise to spasms. It is excreted unchanged in urine and there is no destruction in the tissue as is the case with morphine.

Thebaine

Thebaine has practically no depressant action. The symptoms produced by it resemble those of strychnine, but are not so marked.

Papaverine

In its action on the central nervous system, papaverine is intermediate between codeine and morphine, and is a comparatively weak poison. Papaverine has a greater tendency to slow the heart than morphine; it appears to undergo complete destruction in the tissues.

Narcotine

Narcotine resembles papaverine rather than morphine, but has even less depressant action, especially in mammals. Injection in mammals is followed immediately by a condition of excitement, restlessness and tremors with increased reflexes, which eventually lead to convulsions during which the animal generally succumbs exactly as in strychnine poisoning. Narcotine is much less poisonous than either morphine or codeine.

Narceine and other alkaloids

Narceine has little or no action of any kind. The other alkaloids occur in very minute quantities and very little work has been done to determine their pharmacological action, but those which have been examined appear to produce effects more or less similar to those of the better-known members of the group.

For man morphine is the most dangerous of the opium alkaloids, because death is produced by narcosis and through asphyxia. In the case of most animals, however, thebaine, codeine, and laudanine are more toxic, because the failure of respiration does not occur in the stage of depression, but during the period of convulsions.

KEY TO THE SPECIES

A. Perennial. Capsule oblong or obovate-globose, hispid .. 2. *P. nudicaule*.
B. Annuals. Capsule glabrous.
I. Leaves 1–2-pinnatifid. Filaments filiform.
a. Capsule stalked, subglobose .. .. 3. *P. rhoeas*.
b. Capsule sessile, obovoid .. .. 1. *P. dubium*.
II. Leaves lobed, 2-serrate, amplexicaul. Filaments dilated. Capsule globose, stalked .. .. 4. *P. somniferum*.

1. Papaver dubium Linn.

Fl. Brit. Ind., I, 117.

(Pale-red Poppy, Smooth Long-headed Poppy)

Botanical characters

Habit of *P. rhoeas*, but often glabrous, and leaf-segments usually narrower; hairs of scapes appressed. Flowers 1–2 in. diam. Capsule sessile, obovoid, glabrous; stigma 6–12-rayed.

Distribution

Occasionally met with in the wheat fields in the temperate Western Himalayas from Garhwal and Kumaon to Hazara; also found as a cold-season weed in the plains of Northern India.

Constituents

Alkaloids to the extent of 0·004 to 0·025 per cent have been isolated from the milky juice (*11*), which contains both aporeine and aporeidine. Capsules have been found to contain aporeine to the extent of about 0·015 per cent. This alkaloid produces a burning and numbing sensation on the tongue, and is a tetanic poison (*12*, *13*).

2. Papaver nudicaule Linn.

Fl. Brit. Ind., I, 117.

(Orange Poppy, Yellow Poppy)

Botanical characters

A caespitose herb. Leaves all radical, more or less hairy, pinnatifid or pinnatipartite or more rarely pinnatilobed, $1\frac{1}{4}$–6 in. long including the petiole. Scapes 2–12 in. long, setose-pilose. Flowers scented, 1–2 in. across. Petals white with the base yellow, or orange with the base green, or orange-red. Filaments subulate. Capsule oblong or obovate-globose, usually hispid, $\frac{1}{3}$–$\frac{3}{5}$ in. long.

Distribution

Found in the Western Himalayas and Tibet up to an altitude of 17,000 ft.

Constituents

This herb contains a cyanogenetic glucoside, and 100 gm of fresh leaves during the month of August have been found to yield 3·1 to 5·1 mgm of hydrocyanic acid. The yellow-flowered variety yields more hydrocyanic acid than the red- or white-flowered variety (*14*).

3. Papaver rhoeas Linn.

Fl. Brit. Ind., I, 117.

(Corn Poppy, Field Poppy, Poison Poppy, Red Poppy, Scarlet Poppy)

Vernacular names: ARABIC—Khashkhasul-suda, Nabatul-khashkhasb, Nabztul-khaskhasul-ahmar; BENGAL—Lal-poshta; BOMBAY—Jangli-mudrika; BURMA—Bhain-bin-ami, Bhin-bin-ami; DECCAN—Lal-khaskhas; GUJERAT—Lala, Lal-khaskhas; HINDI—Lal, Lala, Lal-post, Post; KANARESE—Kempu-gasgase, Kempu-khasakhasi; MALAYALAM—Chovanna-kashakasha; MARATHI—Tambada-khasakhasa; PERSIAN—Gule-lala, Khashkhash-siyah, Koknare-surkh; SANSKRIT—Rakta-posta; TAMIL—Shivappu-kashakasha, Shivappu-postaka; TELUGU—Erra-gassagassala, Erra-postakaya; URDU—Gule-lala, Khashkhash-siyah.

Botanical characters

An erect, branched, hispid annual, 1–2 ft. high. Leaves 1–2-pinnatifid; lobes more or less cut, ascending, awned. Scapes with spreading or appressed hairs. Flowers 3–4 in. diam., scarlet, with a dark eye; pairs of petals unequal; filaments filiform. Capsule stalked, sub-globose, glabrous; stigma convex, rays 8–12, overlapping.

Distribution

This plant is met with only in Kashmir and Pangi, but is frequently cultivated in gardens throughout the plains of Northern India, and is often found as an escape in the neighbouring wheat-fields.

Properties

The milk from the capsules has slightly sedative properties.

Constituents

A nontoxic and tasteless alkaloid, rhoeadine, occurs in all parts of the plant (*15*). The capsules are said to contain morphine, paramorphine, and narcotine, in addition to rhoeadine (*16*).

Symptoms

Friedberger and Frohner give the symptoms of poisoning from this plant as colic, constipation, tympanitis in cattle, and raging fits of fury in horses (*17*).

4. Papaver somniferum Linn.

Fl. Brit. Ind., I, 117.

(Carnation Poppy, Opium Poppy, Poppy, White Poppy)

Vernacular names: ARABIC—Abunom, Afiun, Bizrul-khashkhash, Khashkhashul-baiza, Quishrul-khashkhash; BENGAL—Pasto, Posto; BOMBAY—Aphim, Appo, Khashkhas, Post; BURMA—Bhain, Bhainzi; DECCAN—Afim, Khashkhash; GUJERAT—Aphina, Khuskhus, Posta; HINDI—Afim, Afin, Afyun, Kash-kash, Pest, Post; KACHHI—Doda, Post; KANARESE—Afim, Bili-gasgase, Gasagase, Khasakhasi; KUMAON—Posht; MALAYALAM—Afiun, Kashakasha; MARATHI—Aphu, Khuskhus, Posta; NEPAL—Aphim; OUDH—Posta; PERSIAN—Afiun, Khashkhash, Khaskhas-sufaid, Koknar, Poste-koknar, Tukhme-koknar; PUNJAB—Afim, Doda, Khashkhash, Khishkhash, Post; SANSKRIT—Ahifen, Ghosa, Khasa, Khakasa, Ullasata; TAMIL—Abini, Gashagasha, Kasakasa, Postaka; TELUGU—Abhini, Gasagasala, Gasalu, Kasakasa; URDU—Khashkash-sufaid.

Botanical characters

An erect, glaucous annual, 2–4 ft. tall. Leaves ovate-oblong or linear-oblong, amplexicaul, lobed; lobes toothed and serrate. Flowers large, white, sometimes purple or scarlet; filaments slightly dilated.

FIG. 22. *Papaver somniferum* Linn.

Capsule stalked, 1 in. diam., globose, glabrous; stigmatic rays 5–12. Seeds usually white, sometimes black.

Distribution

This plant was at one time largely cultivated, but since the advent of British administration in India its growth has progressively decreased. The Government realized from the outset the injurious effects produced by opium when taken habitually, and have been adopting measures to discourage its use. At the present time poppy cultivation is confined to the United Provinces, districts of Jullundur and Hoshiarpur in the Punjab, and in various States of Rajputana and Central India. But the areas under cultivation are progressively on the decrease. The plant is, of course, widely cultivated for ornamental purposes in gardens.

Capsules

The capsules when unripe yield opium; when ripe and dry they contain only small quantities of the alkaloids and, therefore, their narcotic properties are mild. A warm decoction prepared from them is used as a household remedy as a sedative in fomentations and poultices for application to inflamed parts of the body.

Seeds

The seeds are innocuous and are used in confectionery; they are also regarded as demulcent and nutritive. A bland oil obtained from them is largely employed for culinary and lighting purposes.

Opium as a poison

Opium is so easily available in India and life can be ended with it with such ease and freedom from physical suffering that it is about the commonest drug selected for purposes of suicide. It is said to be mixed with mustard oil or asafoetida in the belief that these substances facilitate the speedy action of the opium. There is, however, no rational basis for this belief. Among cases of poisoning met with in India, nearly 40 per cent of the deaths reported by the chemical examiners of different provinces are due to opium. Owing to its bitter taste, characteristic smell and dark-brown colour, it is rarely used for homicidal purposes, although occasionally employed to get rid of illegitimate children. Some cases of cattle poisoning have also been reported. Accidental poisoning, especially among the labouring classes, who use it to lull their children to sleep, has not infrequently resulted in death from overdose. It may be pointed out here that children are more susceptible to opium and care should be taken in prescribing the drug. Cases of poisoning have also been reported when opiates or morphine preparations have gained access to the system by channels other than the mouth, *e.g.*, application to an abraded surface or wound or even to the intact skin, hypodermic injection or introduction into the rectum or vagina.

Opium contains numerous alkaloids and up to the present time 25 bases (alkaloids) have been recognized. A table showing a list of these

bases, their relative amounts in opium and physiological action is given in the Appendix.

Alkaloidal content

Indian opium is richer in codeine than that produced elsewhere. The amount of morphine in Indian opium varies from 9·5 to 14·2 per cent, codeine 1·8 to 4·0, and narcotine 3·9 to 7·6 per cent, so that there is no reason why opium equal in quality to the Turkey or Smyrna opium should not be available from Indian sources (*18*). A recent paper by Stadelmann (*19*) reviews the chemistry, isolation, etc., of all the 25 alkaloids of opium. For details on opium the reader may refer to standard books, such as those by Henry (*15*) and Allen (*8*).

The morphine content in the capsules (without seeds) varies very greatly; the highest found was about ·0·5 per cent (*20*). Unripe capsules (in August without seeds) showed 0·050 to 0·020 per cent of morphine and 0·0113 to 0·0116 per cent of narcotine and codeine; ripe capsules (in September without seeds) showed the presence of 0·018 per cent of morphine and 0·028 per cent of narcotine and codeine (*21*). The amount of total alkaloids in the unlanced capsules from Indian sources was found to be 0·4 to 0·6 per cent and in the lanced capsules 0·15 to 0·22 per cent (*22*).

The seeds of *P. somniferum* were found by Kerbosch to contain traces of narcotine and of amorphous alkaloids (*23*), while Müller could not find any alkaloid in the seeds tested by him (*24*).

Acute poisoning in man

Poisoning by opium or morphine for suicidal purposes is quite common and there are also many cases of accidental poisoning on record. The symptoms produced are very similar in both drugs except that in case of morphine about $\frac{1}{10}$th of the dose is required and the effects appear much more quickly than in the case of opium. With moderate doses ($\frac{1}{12}$ to $\frac{1}{4}$ grain of morphine) the symptoms set in within a few minutes with flushing of the face, lassitude, and giddiness. There is confusion of ideas, the mouth becomes dry, and the patient complains of intense thirst. The pupils are contracted, respiration and pulse are slowed, the patient soon feels drowsy and in a short time a condition resembling sleep sets in from which the patient awakens after six to eight hours or more, usually feeling refreshed. With larger doses ($\frac{1}{3}$ to $\frac{1}{2}$ grain) the initial symptoms are more or less the same, but sleep supervenes more quickly and is deeper in character. On awakening the patient complains of some heaviness of the head, confusion of ideas, nausea, anorexia, and constipation.

With toxic doses ($1\frac{1}{2}$ to 5 grains) somnolence rapidly passes into a deep sleep and then coma, from which the patient can be partially roused in the earlier stages but relapses promptly. Severe symptoms

generally set in within 5 to 10 minutes after hypodermic administration, or 15 to 40 minutes after oral administration. As coma deepens the patient cannot be roused, the reflexes disappear and the pulse is weak and slow. Skin becomes cold and clammy, the face and lips livid, the pulse very weak and slow. Respiration becomes slow, irregular, stertorous and may assume a periodic character—(Cheyne-Stokes type). Pupils are contracted to a pin point and are insensitive to light; they dilate just before death. Towards the end the respiration loses its periodic character and the patient dies from asphyxia. Death occurs usually in 7 to 12 hours.

Action on animals

Poisoning with morphine is rare amongst animals. The action of the drug as a cerebral poison varies according to the degree of the nervous development of the animal. Thus, doses ordinarily given to dogs for anaesthetic purposes would prove fatal to man. Horses and ruminants are less susceptible.

Kauffman gives the toxic doses on subcutaneous injection as follows: horse, 45 to 75 grains; ox, 75 to 120 grains; small dog, 11·5 grains; and large dog, 15 grains (*25*).

Symptoms produced in animals are mainly due to the action of the drug on the spinal cord, which is relatively more developed than the brain. In the horse and ox, toxic doses of morphine give rise to a period of excitement marked by restlessness, bellowing, laboured breathing, full pulse, sweating, and dilatation of the pupils. These are followed by coma with general loss of sensibility, slow pulse, and subnormal temperature. There is disturbance of the digestive function, leading to nausea, indigestion, and tympany. Sheep show similar symptoms. In dogs, a toxic dose induces excitement and reflex irritability, vomiting, contracted pupils, and sometimes convulsions. Later, coma sets in and death follows from respiratory failure.

Post-mortem appearances are not characteristic, being the same as after fatal asphyxia (*25*).

Treatment

The following lines of treatment are laid down by Ghose (*26*) :—

If opium or morphine is swallowed, emetics, stomach pump, or apomorphine $\frac{1}{10}$ to $\frac{1}{5}$ grain subcutaneously should be given as early as possible. Potassium permanganate is a chemical antidote (1 grain neutralizes 1 grain of morphine), and its solution (4 to 8 grains in 4 to 8 oz of water) should be given at once if the quantity of poison is unknown or large, before emetics or washing. A weak solution of Liquor Potassii Permanganatis ($1\frac{1}{2}$ drachms to tepid water 1 pint) should be employed as a wash for the stomach. The special danger is the failure of respiration and, therefore, respiratory stimulants in the form of hot black coffee

should be used. Atropine $\frac{1}{40}$ grain should be given to excite the centre, but in larger doses it tends to weaken the respiration. Strychnine, $\frac{1}{60}$ grain hypodermically, is repeated every 2 or 3 hours for heart and lungs. Similarly, artificial respiration and inhalation of nitrite of amyl are resorted to. Alternate cold and hot affusions, flagellations, or taps upon the forehead with fingernails, sinapsim, electricity, smelling salts to the nose, and making the patient walk to and fro, should be adopted to keep the patient awake. Oxygen inhalation is also recommended. The treatment is to be kept up for several hours until the danger is over. Some recommend frequent washing of the stomach as opium is excreted in it, but that is unnecessary as the quantity is infinitesimal and the resulting exhaustion excessive.

CHRONIC POISONING

Chronic opium and morphine poisoning is met with in many parts of the world generally and in India particularly. It is not known with certainty whether the regular use of very small doses ($\frac{1}{2}$ to 1 grain daily) of opium over prolonged periods produces any markedly deleterious effect. Even moderate doses of opium (2 to 5 grains daily) are said to be indulged in, in some countries, apparently without any markedly injurious effect, and opium eaters in India who stick to small doses are said to enjoy fairly good health and are long lived. There is no doubt, however, that constant consumption of large quantities leads to serious results.

Prevalence of the habit

Although opium is habitually used by large sections of the population in India, its indulgence is not so widely prevalent as might be imagined from some recent publications on the subject. Poppy capsules are known to have been used for their soporific properties by the ancient Egyptians, Greeks, and Romans. During the Moghul era the capsules were extensively used to prepare a beverage which was taken for euphoric or pleasure-giving effects. The habitual use of the poppy capsules for such purposes has considerably decreased in India during the last three decades. On the other hand addiction to morphine has increased during recent years. No systematic investigation had been carried out in India with regard to the physical and mental effects produced by the habitual use of opium and its preparations until recently when Chopra and his collaborators undertook laborious studies under the auspices of the Indian Research Fund Association (*27*, *28*, *29*, *30*, *31*, *32*, *33*, *34*, *35*).

Mode of consumption

Opium and its derivatives are taken in three ways: by smoking, by mouth, and by injection. Smoking of opium has been known for ages among the people of the Orient. Two preparations employed in

India are called 'Madok' and 'Chandu'. Although smoking of opium is still prevalent in some parts of India, the commonest method is taking the drug by mouth. The method of self-administration by hypodermic injection of either sulphate or hydrochloride of morphine and some other alkaloids is used in Western countries and is now spreading into India and China. This method is becoming more and more popular as addicts obtain the effects of the drug more quickly and intensely. They have also discovered that this form of medication does not upset the stomach and digestion so much as taking the drug by mouth.

Symptoms and effects

The symptoms of chronic poisoning with opium and its derivatives vary considerably. In the first place there is the individual to be considered, then the length of time such addiction has persisted and also the quantity of the average daily dose. The immediate effects are essentially the same as in the unhabituated individual but the response varies quantitatively and in some degree qualitatively, because of acquired tolerance. The effect of habitual use of these drugs is primarily an insatiable desire for more and more frequent and larger doses to receive the same stimulation and the same sensation of comfort.

The effects of moderate addiction on the general health are not very marked. A great majority of the addicts taking moderate doses enjoy apparently good health. Persons addicted to larger doses, in whom the dose exceeds 10 grains daily, have a pale-sallow appearance and also a peculiar pigmentation around the mouth, cheeks, and eyelids. The pupils are contracted in addicts taking large doses, and react to light and accommodation rather slowly. The prolonged abuse of the drug results in a disordered metabolism leading to a chronic toxaemia and this in all probability is responsible for the loss in body weight. The general vitality of the individual is lowered on account of impairment by the drug of the proper functions of the respiratory, digestive, and nervous systems. From a study of the physical properties of the blood sera of opium addicts (*34*), it has been found that the habit leads to an increase in the watery content of the plasma, raises its hydrogen-ion concentration, and lowers its buffer action and globulin content. These changes result in defective regeneration and growth of body cells. Opium eaters, as a rule, cannot work sufficiently hard to earn a decent living. This leads to a lowering of the general nutrition of the body and a fall in weight. In old addicts, taking more than 15 grains a day, the skin is usually dry and loses its natural elasticity; the hairs are often dry and thin. Opium addiction, besides producing impairment of the body

functions, leads to a diminished sensitiveness of the mucous membranes of the respiratory tract so that the addict is always a victim to minor respiratory disorders. It inhibits protoplasmic activity and thus may delay recovery from various chronic affections. When the habit has persisted for many years the pulse alters in character, becomes full and of high tension ; the blood vessels become hard and are not easily compressible. Opium addiction does not affect the haemopoietic system directly, but a certain amount of anaemia and changes in the blood occur indirectly as a result of the lowering of the general vitality of addicts.

In opium addicts, the gastro-intestinal tract bears the brunt. The tongue is usually dry, flabby, cracked, thickly coated, and the breath offensive, indicating subnormal gastric and hepatic functions. Most habitués suffer from a loss of appetite and a feeling of heaviness in the epigastrium. Nausea is not generally found. Digestion, especially that of carbohydrates, is not obstructed. The caecum and colon are generally loaded ; defecation becomes very tedious and difficult ; the stools are dry and hard. In the majority of cases, the emptying of large intestines is incomplete. Withholding of the drug in some addicts produces symptoms of acute gastro-enteritis, severe pain in the abdomen, followed by diarrhoea and sometimes bloody stools.

Mental effects

When addicts are actually under the influence of the drug, it exercises a powerful euphoric effect, stimulates and refreshes them for the time being, and induces forgetfulness of mental worries by depressing the higher centres of the brain. The mental faculties are affected more and more as the dose is increased and mental injury is more likely to occur in those taking large doses over prolonged periods. Habitués, from constant use of the drug, become careless and lazy ; weakness of character is apparent in all stages of addiction. Depression and melancholia are frequently seen after many years of addiction and dementia is an occasional occurrence, especially in those who have an unlimited supply at their command.

Abstinence symptoms

The sudden giving up of the accustomed dose produces abstinence symptoms in the form of a craving for the drug. A train of severe nervous symptoms follows, the intensity of which varies with the individual, and increases with the duration of addiction, the dose taken and the rapidity with which the drug is withdrawn.

With addicts of shorter duration, the symptoms are restlessness, weakness and depression ; these are endurable and disappear soon after the withdrawal of the drug. With confirmed addicts, however, the symptoms are more intense. Severe functional digestive disturbances,

concentration of blood and negative water balance (*35*), cramps, headache, persistent insomnia and sometimes collapse are prominent features. These symptoms generally start within 24 hours, reach their climax in 72 hours, and gradually subside in 5 to 7 days.

The symptoms are considered by some to be mostly psychic and apparently are very largely under the control of the individual. If the patient expects to arouse sympathy the symptoms are stronger, while they are practically absent if he is kept under the influence of scopolamine (*36*).

Treatment

The treatment of chronic opium poisoning in those addicted to this drug had long been regarded as not very promising. This was due in part to the unsuitable methods employed for making the patient give up the drug habit and the difficulty of having patients confined for a sufficient length of time to effect what might be regarded as a real cure and self-habilitation.

The primary indication is the removal of the cause which must be done under proper medical supervision and in a special institution if possible. The withdrawal of the drug by the "sudden method" advocated by Bonhoeffer has been recognized to be scientifically the best method of treatment in many countries. The slow or the gradual method of withdrawal has also met with a great deal of success in the hands of many workers. By this method it takes three to six weeks to effect a cure in most of the Indian addicts undergoing treatment. The decrease in dosage is carried out very gradually at first; after a few days it can be effected more rapidly, until in three to four weeks' time the drug can be stopped entirely.

Other forms of special treatment recommended are by giving injections of insulin or by injecting 2 to 3 c.c. of a fluid obtained from raising a blister on the thigh or abdomen of the addict himself. Two or three such injections at intervals of five days are said to produce a strong distaste in the addict for the drug—Modinos (*37*).

A modification of the lecithin treatment suggested by Ma (*38*) has been tried in India by the senior author with promising results, both in opium and morphine addicts of long standing. From observations made on the physical properties of the blood sera of opium addicts, it was found that the protein content, especially the neuroprotein, is lacking or deficient particularly during the withdrawal period; and it was considered that by giving lecithin this deficiency could be made good.

Chopra's treatment

Chopra's treatment (*39*) is carried out as follows:—

On the evening before the treatment is to be started the patient is given a dose of calomel (4 to 5 grains), followed by a saline purgative

the next morning. The drug is then suddenly and completely withdrawn and the patient watched for the development of withdrawal symptoms, which in the majority of cases start on the same day and attain their maximum within 24 hours. The actual treatment was formerly started when the withdrawal symptoms became intense and unbearable, but lately it has been found distinctly advantageous to start administering lecithin and glucose the day before opium is withdrawn.

Lecithin (ovolecithin Merck) is given by mouth in doses of 15 to 20 grains three times a day, and continued usually for 5 to 7 consecutive days. In certain number of cases lecithin by mouth produces nausea, and in these cases the drug is given in the form of a colloidal solution by intramuscular injection, specially prepared for the purpose, the usual dose being 2 c.c. of 1 per cent solution twice daily for 2 to 4 days or longer. Experience has shown that lecithin, when given by injection, acts just as effectively as when it is given by mouth, and in some cases even better. There is no doubt that in the majority of cases lecithin decreases the intensity of the withdrawal symptoms and shortens their duration. In spite of its administration the abstinence symptoms are severe in some of the patients, and in these cases intravenous injection of 25 c.c. of 25 per cent glucose as well as glucose by mouth greatly help to ameliorate the condition. These are given with a view to stocking the liver with glycogen and in order to enable it to cope with the strain, which no doubt falls on this organ during the process of elimination of morphine and other alkaloids of opium from the system. An intravenous injection of glucose usually is given every morning for the first three or four days, and if necessary may be repeated in the evening. The injections are then stopped and glucose, if still required, is given by mouth. No further treatment is needed after the first week and no other drug is necessary during this period, except a brisk saline purgative every morning to help in the elimination of the alkaloids through the gastro-intestinal tract.

The diet during this period should be light because patients, as a rule, cannot take much on account of gastro-intestinal disturbances produced by the withdrawal. Glucose, milk, and fruit juices, however, may be given freely by mouth for the first two or three days during the withdrawal period. On the fourth day, when the abstinence symptoms begin to disappear and appetite returns, a diet rich in proteins and lecithin in the form of eggs, milk, beans, fish, chicken, fruits, bread, and butter should be given.

After the completion of the actual treatment, that is, after the complete withdrawal of the drug, patients are further kept under

observation in the hospital for a fortnight or more. A twenty-four hour specimen of urine is examined for the presence of morphine, to make certain whether any of these patients is taking the drug secretly.

Habitual Use in Infants

Administration to infants

Habitual administration of opium to infants at certain periods of their lives has been prevalent in India for many centuries. The habit appears to have been started because of the drug's power of allaying diarrhoea and vomiting; also of relieving cough and pain, and producing sleep. The custom, although it is still met with in almost every part of India, has greatly declined during the last two or three decades. The drug, however, is still extensively employed for these purposes in the Central Provinces and Berar, and industrial areas in all parts of India.

Symptoms and treatment

The symptoms produced are more or less the same as in the case of adults. An important result of the practice is constipation, while general physical condition and health are poor. It must also be remembered that opium hinders the normal growth of a child on account of the toxaemia it produces. Children taking opium are as a rule thin, anaemic and emaciated, and are more liable to catch infections. The mortality rate among them is also comparatively high.

The habit in infants and children is not difficult to break. Both the gradual and sudden methods of withdrawal have been tried with equal success, but it is better to adopt the sudden method. The withdrawal symptoms met with are looseness of bowels, diarrhoea, and irritability of temper. In severe cases loss of appetite, nausea, and abdominal pains also occur. These are dealt with symptomatically. The child usually gets well in a few days and a cure is effected. No after-treatment is as a rule necessary.

ADMINISTRATION TO ANIMALS

Reference has been made in literature that large quantities of opium are given to animals, *viz.*, elephants, horses, etc. This practice may have been in vogue fifty years ago, particularly in the Punjab and Bengal, but with the exception of Afghan horse dealers and thieves and dacoits, who administer the drug to the animals to enable them to endure heavy physical strain, it is now obsolete.

The solid residue left after the preparation of a beverage from 'post' (unlanced dried capsules of *P. somniferum*) is occasionally given to domestic animals, and it is interesting to note that when the supply is not forthcoming, the animals appear to show withdrawal symptoms

in a greater or less marked degree. It is probable that they react to this withdrawal as they would to hunger and thirst.

SANGUINARIA Dill. *ex* Linn.

(From the Latin *sanguis, sanguinis*—blood; the plant yields a red juice when cut or broken.)

Sanguinaria canadensis Linn.

(Bloodroot, Puccoon)

Uses

This is an American plant which is occasionally employed as an expectorant in chronic bronchitis and is administered in form of a tincture.

Toxicity

The plant is distinctly poisonous and it has been recorded that fatal results have followed from overdoses. On account of its peculiar blood-red colour as well as an exceedingly acrid and bitter taste, the rhizome is not likely to be eaten (*17*).

Constituents

The roots contain the alkaloids chelerythrine, sanguinarine, protopine and α- and β-homochelidonine (*15*). A new alkaloid, oxysanguinarine, has been isolated more recently (*40*).

Physiological action

The bitter and acrid taste of bloodroot is due to the presence of the alkaloid sanguinarine which in small doses exerts a tonic influence, promoting gastro-intestinal secretion and thus aiding digestion. This alkaloid is said to be very acrid to taste, is toxic, and causes violent sneezing (*17*).

Millspaugh, as quoted by Pammel (*17*), gives the physiological action as follows :—

" Sanguinaria in toxic doses causes a train of symptoms showing it to be an irritant ; it causes nausea, vomiting, sensations of burning in the mucous membranes whenever it comes in contact with them, faintness, vertigo, and insensibility. It reduces the heart's action and muscular strength, and depresses the nerve force, central and peripheral. Death has occurred from overdoses, after the following sequence of symptoms : violent vomiting, followed by terrible thirst and great burning in the stomach and intestines, accompanied by soreness over the region of those organs ; heaviness of the upper chest with difficult breathing ; dilation of the pupils ; great muscular prostration ; faintness and coldness of the surface, showing that death follows from cardiac paralysis ".

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Family VII.—FUMARIACEAE

(Fumitory Family)

Botanical characters

Herbs with watery juice. Leaves usually divided; segments not jointed. Flowers irregular, racemed. Sepals 2, small, deciduous. Petals 4; 2 outer larger, one or both gibbous or spurred; 2 inner smaller, erect, often coherent at the tip. Stamens 6, in 2 bundles (4, free in *Hypecoum*), opposite the outer petals. Ovary 1-celled; stigma obtuse or lobed; ovules 2 or more, parietal. Fruit a 2-valved, many-seeded capsule, or an indehiscent 1-seeded nut.

Distribution

Chiefly in temperate and warm regions of the Northern Hemisphere.

Toxic aspects

Some foreign representatives of *Dicentra* and *Corydalis* have been studied systematically and have been found to contain a number of toxic alkaloids. *Dicentra canadensis* Walp. (squirrel corn, turkey corn) contains protopine, bulbocapnine, corydine, and *iso*-corydine. *D. cucullaria* Bernh. (Dutchman's-breeches) contains protopine, cryptopine, bicuculline, bicucine, corlumine, and ochotensine. The roots of *Corydalis tuberosa* DC. contain corydaline, dehydrocorydaline, corybulbine, *iso*corybulbine, corypalmine, corycavine, corycavamine, corycavidine, bulbocapnine, corytuberine, glaucine, canadine, corydine, and various other alkaloids (*1*). These plants are used in medicine.

All the alkaloids except corytuberine produce narcosis in frog similar to that induced by morphine; they also produce depression of the heart. Corytuberine causes tonic convulsions with small increase in reflex excitability, slowing of the heart's action by stimulation of the vagus and increase in the rate of respiration, while bulbocapnine produces a cataleptic condition, especially in cats. Repiration is also slowed by bulbocapnine (*1*).

Several species of *Corydalis* and *Dicentra* are found in the Himalayas and Tibet, and it would be interesting to investigate their poisonous properties. Cases of poisoning due to some exotic species have been reported.

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Family VIII.—CRUCIFERAE

(Mustard Family)

Botanical characters

Herbs, rarely undershrubs; juice watery, often pungent. Radical leaves in a rosette, cauline alternate; stipules 0. Flowers usually racemose or corymbose, ebracteate. Sepals 4, free. Petals 4, free, often long-clawed, placed crosswise, imbricate, rarely 0. Stamens usually 6, 4 inner longer, in opposite pairs. Ovary 2- or 1-celled, or with many superposed cells; ovules many, rarely 1 or 2; style short or 0; stigma entire or 2-lobed. Fruit either a 2-celled 2-valved (in some cultivated forms of *Brassica* more-valved) pod (siliqua if long, silicula if short), the valves breaking away from the persistent placentas (replum), or indehiscent, or transversely jointed. Seeds small; albumen 0; cotyledons plano-convex or longitudinally folded; radical turned upon the back of one cotyledon (incumbent), or facing the edges of both (accumbent).

Distribution

Natives of the temperate climates, especially round the Mediterranean region; a few on mountains in the tropics.

Economic and toxic aspects

Many of the culinary vegetables of temperate countries are derived from this family, *e.g.*, cabbages and turnips (*Brassica* species), radishes (*Raphanus sativus* Linn.), and garden cress (*Lepidium sativum* Linn.). Many are ornamental plants, *e.g.*, candytuft (*Iberis odorata* Linn.), stock (*Matthiola incana* R. Br.), treacle mustard (*Erysimum cheiranthoides* Linn.), and wallflower (*Cheiranthus cheiri* Linn.). 'Taramira' (*Eruca sativa* Mill.) is extensively cultivated for its oil-yielding seeds and as a green fodder for the cattle.

Members of this family are not ordinarily classed as poisonous plants and are frequently grazed by livestock. They are generally characterized by their stimulant and antiscorbutic properties. The seeds are oleaginous and frequently pungent. The characteristic odour of the plants in a crushed state or when the seeds are ground with water is due to an essential oil, liberated by the action of the enzyme myrosin.

The seeds of the genus *Brassica* and of some other genera, *viz.*, *Sisymbrium* (*e.g.*, *S. irio* Linn.), *Capsella* (*e.g.*, *C. bursa-pastoris* Medic.—shepherd's-purse), *Eruca* (*e.g.*, *E. sativa* Mill.), etc., have rubefacient and vesicating properties. After expression of the oil, the residual cake of certain mustards is used as a feed for livestock. Owing to the presence of the essential oil, injudicious feeding of this residual cake

is likely to be harmful. We consider later in some detail only those mustards which are of importance to India.

Some species of *Lepidium* are used as fish poisons; of these *L. draba* Linn. is found in India. *Cheiranthus cheiri*, a garden plant in India, contains the glucoside cheiranthin which is present in the largest amount in its seeds; this glucoside is a violent cardiac poison. *Erysimum crepidifolium* Reichb. of Europe contains a bitter substance erysimupicron and is said to be toxic to geese (*1*); it is also stated to produce the condition known as "staggering" in animals (*2*).

Constituents

Members of this family have been found to contain: (*a*) *glucosides*, such as sinalbin, sinigrin, glycotropaeolin, cheiranthin, glucocheirolin, etc., (*b*) *bitter substances*, such as erysimupicron, (*c*) *essential oils* containing substances, such as allyl *iso*thiocyanate or allyl mustard oil, propenyl mustard oil, allyl cyanide, carbon disulphide, dimethyl sulphide, crotonyl *iso*thiocyanate, acrinyl *iso*thiocyanate, *iso*butyl *iso*thiocyanate, etc., and (*d*) *fixed oils*, such as those of mustard, rape, etc.

KEY TO THE GENERA

a. Flowers yellow. Pod linear or oblong, terete or angular, beaked. .. .. 1. *Brassica*.

b. Flowers white. Pod short, compressed laterally .. .. 2. *Lepidium*.

1. BRASSICA (Tourn.) Linn.

(Old classical name.)

Botanical characters

Glabrous or hispid herbs. Leaves large, pinnatifid or lyrate, upper often entire. Flowers yellow, in long racemes. Lateral sepals usually saccate at the base. Pods elongate, terete or angular, beaked; valves biconvex, with one prominent midrib, lateral nerves flexuose. Stigma truncate or 2-lobed. Seeds 1-seriate, globose or subcompressed; cotyledons longitudinally folded.

Distribution

Temperate regions of the world; chiefly cultivated.

This is a group of herbaceous plants containing mustards, cabbages, cauliflower, broccoli, borecole, kohlrabi or knol-kohl, and turnips with their numerous varieties. Under cultivation the forms have been and are increasing indefinitely.

Chemistry of mustards

The mustards [including the white mustard (*Sinapis alba* Linn., syn. *Brassica alba* Boiss.)] generally contain 25 to 37 per cent of a fixed oil, the glucosides sinigrin or sinalbin, and an enzyme myrosin.

Black-mustard seeds [*B. nigra* (Linn.) Koch] contain the glucoside sinigrin. This is hydrolyzed by myrosin to dextrose, allyl mustard oil

(essential oil) or allyl *iso*thiocyanate and potassium hydrogen sulphate. White-mustard seeds contain the glucoside sinalbin and the enzyme myrosin. The glucoside sinalbin is hydrolyzed by myrosin to dextrose and p-hydroxybenzyl *iso*thiocyanate or sinalbin mustard oil and sinapin hydrogen sulphate.

Essential oil

The essential oil of mustard does not exist as such in the seeds, but is formed by the action of the ferment myrosin upon sinigrin in the presence of water. It is obtained by macerating the fat-free crushed seeds with water, allowing it to stand for a time for the reaction to take place and then distilling in steam. It has also been observed that the best results are obtained by macerating for 2 hours ; slightly lower amounts are obtained by 4-hours' maceration, whilst with 24-hours' maceration the yield of the oil is reduced to 30 per cent. The destruction of the oil is due to bacterial activity which is retarded by the addition of sodium fluoride, thymol or boric acid (*3*). In addition to allyl *iso*thiocyanate, the oil contains small quantities of carbon disulphide and allyl cyanide. This essential oil has proved an efficient preservative for wines. One c.c. of a 1 per cent solution added to one litre of wine is generally effective and does not affect the odour or flavour. It is a rapidly acting skin irritant and produces almost instantaneous redness with pricking pain followed by hyperaemia. The other product (sinalbin mustard oil), obtained by the action of myrosin on sinalbin, is volatile in traces in steam only and is, therefore, devoid of the pungent odour or irritant effect on the eyes ; it, however, acts as a vesicant.

Nomenclature of Indian mustards

As is generally the case with much-cultivated plants, there exists considerable confusion in the nomenclature of some of the brassicas. In India this is particularly the case with *B. napus* Linn. and *B. campestris* Linn. and their varieties. In this connection reference may be made to the " Flora of British India " (1872), " Field and Garden Crops of the North-Western Provinces and Oudh " by Duthie and Fuller (1883), " Dictionary of the Economic Products of India " by Watt (1889), Prain's work on the cultivated mustards of Bengal in the " Agricultural Ledger " (1898), and the latest monograph by Schulz in " Das Pflanzenreich " (1919). From the economic and commercial points of view, however, most of these are well understood in India. It is not intended to go into the details of this question, and only some of the important plants which come within the scope of this work are discussed below. The classification of Schulz is followed and most of the botanical information is also based on the work of that author.

B. napus

Following the arrangement adopted by Schulz, the Indian rape (' tori ', ' toriya ') falls under *B. napus* Linn. while the different kinds of

'sarson' or the Indian colza are referred to as varieties of *B. napus*. The oil ('karwa tel', 'sarson' oil) expressed from the seeds of 'sarson' forms an important ingredient in Indian cookery and is also largely used for lighting and other domestic purposes. The residual cake is used for feeding cattle.

The seeds from which 'sarson' or 'karwa' oil is obtained are generally poor in glucosidal content and hence also in the toxic essential oil of mustard. The oil, which is largely consumed, may be deleterious, but only when it is contaminated with the volatile oil of mustard, the quantity of which depends on the quality of the seeds and the mode of expression of the oil. The cold-drawn oil is, therefore, very rarely contaminated, unless it is desired by the vender to give it a pungent smell which is much appreciated by consumers who, without any rational basis, consider it to be a criterion of purity for the oil. For this purpose seeds of other varieties of mustard rich in volatile oil and even capsicum seeds are mixed along with the 'sarson' seeds. Nowadays, however, the synthetic essential oil of mustard (allyl *iso*thiocyanate), being cheaper and more effective in this respect, is very frequently used as an adulterant. It follows, therefore, that the more pungent the oil, the more toxic it is likely to be.

It has been suggested that mustard oil plays a part in the production of epidemic dropsy. From what has been said under *Argemone mexicana* Linn., *Schleichera oleosa* (Lour.) Merr. (*S. trijuga* Willd.), and *Oryza sativa* Linn., this statement must be accepted with reserve. Symptoms closely resembling that of epidemic dropsy are undoubtedly produced by adulterated oils, but more evidence is necessary before its role in the causation of this disease can be definitely established (*see* under *Argemone mexicana*). Bose and Sen (*4*) have reported that the oil is occasionally adulterated with that of *Schleichera oleosa* which gives rise to symptoms of irritant poisoning (*see* under *Schleichera oleosa*).

Poisoning of cattle fed on 'sarson'-seed cake appears to be rare in India because, as stated already, the seeds used for the expression of the oil are poor in glucosidal content and hence in the toxic essential oil. In fact the cake forms an excellent cattle food if the seeds are pure and uncontaminated by the poisonous seeds of other mustards, *viz.*, the black and the white mustard and 'rai'. Cozettr (*5*) records a case of cattle poisoning by colza cake of Indian origin containing various species of mustard seeds. If, however, the pure 'sarson' cake is fed in large quantities over a prolonged period, symptoms of poisoning may be produced. Those described by Steyn (*6*) under *B. napus* are: Chronic enteritis with hoven, bloody diarrhoea, colic, haematuria, symptoms of cerebral stimulation, apathy, lassitude, symptoms of paralysis, paralysis of the

heart and respiration. Pregnant animals may abort. The danger, however, can be averted by pouring boiling water over the crushed cake, as the enzyme responsible for the production of the toxic principle is destroyed by heat.

B. campestris

So far as is known the seeds of *B. campestris* Linn. and its varieties are not used in India for the expression of oil nor is the residual cake fed to animals. The thickened, fleshy, edible roots (turnips) of *B. campestris* Linn., var. *rapa* (Linn.) Hartm. are, however, commonly used as a vegetable in India, and poisoning by its seeds has been referred to in foreign literature. Several Indian publications deal with 'sarson' as a variety of *B. campestris*, but following Schulz it is regarded as a variety of *B. napus* in this work.

'Rai' group

There are three different species, *viz.*, *B. juncea* (Linn.) Czernjaëw & Cosson, *B. integrifolia* (West) O. E. Schulz, and *B. cernua* (Thunb.) Forbes & Hemsley, which are known as 'rai'. Of these *B. juncea*, the 'asal rai', is probably the most important crop from the point of view of seeds. This is in fact the plant which goes under the name of mustard in India and takes the place of *B. nigra* (Linn.) Koch of foreign countries. The seeds are commonly met with in Indian bazars and from their colour may be denominated as brown-mustard seeds. They possess properties similar to those of the black- and white-mustard seeds for which they may be employed as an efficient substitute, especially in the preparation of mustard poultices. The seeds yield an oil which, according to Watt (7), is of a much purer kind and devoid of the peculiar smell of the oil of the Indian rape and Indian colza. According to the same author, its oil is most commonly employed as an article of food in the plains of India, but much credence cannot be given to this statement.

B. nigra

The black or true mustard [*B. nigra* (Linn.) Koch] is sparingly cultivated in India. A bland oil expressed from the seeds is used for various economic purposes in foreign countries. The defatted seeds are, however, largely used as a condiment and also in medicine as rubefacient and vesicant in the form of mustard plaster.*

Taken internally in doses of one to four teaspoonfuls mustard acts as an emetic; larger doses produce violent gastro-intestinal irritation. Mustard plasters should not be applied to large areas of skin at the same time, as the pain produced may be intolerable. The action of the plaster goes deep, for the light volatile oil present in it

***N.B.*—The mustard of commerce consists of a mixture of the ground seeds of *Brassica nigra* and *Sinapis alba*. The *Sinapis nigra* of the U. S. Pharmacopoeia is the dry ripe seed of *B. nigra* (Linn.) Koch, of *B. juncea* (Linn.) Czernjaëw & Cosson or their varieties, and should not contain less than 0·6 per cent of allyl *iso*thiocyanate (Allen).

speedily penetrates into the deeper layers of the skin where it sets up an inflammation. The volatile oil acts as a powerful antiseptic; its minimum lethal dose is stated to be $\frac{1}{5}$th minim per kgm. It cannot be recommended for internal administration; even its excessive inhalation is attended with risk.

White mustard

The white mustard, *Sinapis alba* Linn. (*Brassica alba* of Fl. Brit. Ind.), is very rarely cultivated in India. It resembles *B. nigra* in its properties.

KEY TO THE SPECIES

A. Ovary multi- (9–45-) ovulate. Pods large, 1·5–10 cm. long. Beak distinctly conical, sometimes as thick as the pod, often 1- or 2-seeded.

- I. Stem-leaves amplexicaul .. .. .. 4. *B. napus*.
- II. Stem-leaves sessile or petiolate.
  - *a*. Lower leaves distinctly 2–3-jugate at base. Pods 2–3·5 mm. broad; beak 6–10 mm. long .. 3. *B. juncea*.
  - *b*. Lower leaves not or slightly lobate at base. Pods 1–2 mm. diam.; beak 1·5–7 mm. long, rarely up to 10 mm. long.
    - *aa*. Leaves with a plain margin .. .. 2. *B. integrifolia*.
    - *bb*. Leaves with a crisp margin .. .. 1. *B. cernua*.

B. Ovary few- (7–11-) ovulate. Pods small, 1–2 cm. long. Beak very thin, always seedless .. .. 5. *B. nigra*.

1. Brassica cernua (Thunb.) Forbes & Hemsley

B. juncea Hook. *f.* & Thoms., Fl. Brit. Ind., I, 157, in part; subsp. *rugosa* Prain, var. *typica* Prain, Agric. Ledger, 1898, no. 1, 47.

(Cabbage-leaved Mustard)

Vernacular names: BENGAL—Pahari-rai, Palangi, Pasai.

Botanical characters

Lower leaves persistent, very broad, obovate, margin crisped, with about 5 obsolete lobes which are densely and acutely dentate; central nerve very stout; top-leaves oblong, subentire or entire; all green. Flowering racemes cernuous. Otherwise like *B. integrifolia*.

Distribution

Cultivated as a cold-weather crop in the Western, Central, and Eastern Himalayas, more for its leaves than for the seeds.

2. Brassica integrifolia (West) O. E. Schulz

B. juncea Hook. *f.* & Thoms., Fl. Brit. Ind., I, 157, in part; subsp. *rugosa* Prain, var. *cuneifolia* Prain, Agric. Ledger, 1898, no. 1, 47.

(Indian Mustard)

Vernacular names: Rai, Lahi-sag.

Botanical characters

Stem often purplish up to the pedicels. Basal leaves long-persistent, broadly obovate, cuneately narrowed into the petiole, unequally and

more or less coarsely dentate; upper ones broadly linear, entire; all glabrous, rarely the lower setulose. Ovary 12–18-ovuled. Pod 3–4 cm. long, 1–2 mm. diam., attenuate into a beak 3–7, rarely 10 mm. long. Seeds 1–1·3 mm. diam.

Distribution Cultivated as a cold-weather crop in the Punjab, Assam, and North Bengal.

3. **Brassica juncea** (Linn.) Czernjaëw & Cosson

B. juncea Hook. *f.* & Thoms., Fl. Brit. Ind., I, 157, in part; subsp. *juncea* Prain, var. *oleifera* Prain, Agric. Ledger, 1898, no. 1, 47.

(Indian Mustard)

Vernacular name: Asal rai.

Botanical characters Annual. Stem terete. Lower leaves distinctly petiolate, lyrate-pinnatisect, 2–3-jugate; terminal lobe largest; upper leaves narrowed in a small petiole. Racemes lax, 20–40-flowered. Petals pale-yellow. Pods on pedicels 1·6–0·6 cm. long, erecto-patent or suberect, broadly linear, 3·2–5·6 cm. long, 2–3·5 mm. broad, subtetragonous, torulose, gradually attenuate in a seedless beak 6–12 mm. long. Seeds globose, 1·3 mm. diam., obscurely purple-brown or rarely yellow, alveolate.

Distribution Much cultivated in Upper India; also in the low-lying hills of the Athur Taluk of Salem District in the Madras Presidency.

Varieties Three varieties are met with under cultivation in India. They are: (*a*) var. *elata* (Prain) O. E. Schulz, (*b*) var. *aspera* (Prain) O. E. Schulz, and (*c*) var. *paevis* (Prain) O. E. Schulz.

Constituents The seeds contain 0·3 to 1·137 per cent of essential oil of mustard (*1*); the Bombay variety yields 1·07 per cent (*3*). The essential oil has been found to contain 40 per cent of allyl mustard oil, about 50 per cent of crotonyl mustard oil, probably some allyl cyanide and traces of dimethyl sulphide (*8*).

4. **Brassica napus** Linn.

B. campestris Linn., subsp. 1. *campestris* and subsp. 2. *napus* Hook. *f.* & T. Anders., Fl. Brit. Ind., I, 156.

(Indian Rape)

Vernacular names: Tori, Toriya, Kali-sarson.

Botanical characters Glaucous annual. Stem 1–5 ft. high, often violaceous below. Basal leaves lyrate-pinnatisect, terminal lobe the largest; lower stem-leaves lyrate-pinnatifid, upper gradually lanceolate, all dilated and

amplexicaul at the base. Racemes at flowering time laxly corymbose, with flowers not surpassing the flower buds, later on very elongate, 25–40-flowered. Petals 0·9–1·8 cm. long. Ovary 20–40-ovuled. Pods erecto-patent, on pedicels 0·8–3 cm. long, linear, curved in the upper part, 5–8·8 cm. long, subterete, 2·5–4 mm. broad, torulose; beak flattened 0- or 1-, rarely 2-seeded. Seeds globose, 1–1·5 mm. diam., obscurely purple-brown, black near the hilum, minutely reticulate-alveolate.

Distribution

Cultivated as a cold-weather crop in Northern India from the Punjab to Bengal and in parts of Chota Nagpur.

Varieties

The following four varieties of mustard belonging to this species are cultivated in India. They form the Indian colza or 'sarson' of commerce.

A. Stem glabrous. Leaves glabrous or sparsely setulose.

1. Var. monstrosa *quadrivalvis* (Hook. *f.* & Thoms.) O. E. Schulz=*B. quadrivalvis* Hook. *f.* & Thoms., Fl. Brit. Ind., I, 156.
   The pods are erecto-patent and 4-valved, small.
2. Var. *ulti* (Prain) O. E. Schulz
   The pods are more or less pendulous, 2-valved.
3. Var. monstrosa *trilocularis* (Roxb.) O. E. Schulz=*B. trilocularis* Hook. *f.* & Thoms., Fl. Brit. Ind., I, 156.
   The pods are 3–4-valved, pendulous.

B. Stem scattered-setulose below. Leaves mostly setulose and ciliate. Seeds occasionally ash-coloured or reddish.

4. Var. *glauca* (Roxb.) O. E. Schulz

Constituents

The different varieties of *B. napus* so far examined have been found to contain 0·056 to 0·22 per cent of essential oil in the seeds (*1*).

5. **Brassica nigra** (Linn.) Koch

Fl. Brit. Ind., I, 156.

(Black or True Mustard)

Vernacular name : Kali-rai.

Botanical characters

Erect annual. Stem more or less hispid, often purple-spotted or purplish in sunny places. Lower leaves distinctly stalked, lyrate-pinnatisect; upper leaves oblong-linear, narrowed into a short petiole, mostly entire. Racemes at flowering time corymbose, later very elongate, 40–60-flowered. Petals truncate and undulate at apex. Fruiting pedicel 2·5–4·5 mm. long, erect. Pods 1–2 cm. long, 1·5–2 mm. diam., linear, subtetragonous, torulose; beak 1·5–2·5 mm. long, thin, seedless. Seeds globose, 1 mm. diam., obscurely brown, black near the hilum, delicately alveolate.

Distribution

Sparingly cultivated in various parts of India.

O

Constituents

The seeds contain 0·66 to 1·23 per cent of essential oil of mustard (*9*). This oil contains 96·0 to 97·7 per cent of allyl *iso*thiocyanate depending on the age of the oil and also small amounts of allyl cyanide and carbon disulphide (*10*).

2. LEPIDIUM Linn.

(The classical name for the garden cress, *Lepidium sativum* Linn.; from the Greek *lepidion*, diminutive of *lepis*—a scale, probably referring to the form of the pods.)

Botanical characters

Diffuse or erect herbs, undershrubs or shrubs. Leaves entire or divided. Flowers small, white. Sepals short, equal at the base. Petals sometimes 2–4 or 0. Stamens 6, 4, or 0. Pods ovate or oblong, rarely globose, usually orbicular, laterally much compressed, tip notched or entire; valves boat-shaped, keeled or winged, septum narrow, membranous. Seeds solitary in each cell; cotyledons incumbent.

Distribution

Cosmopolitan.

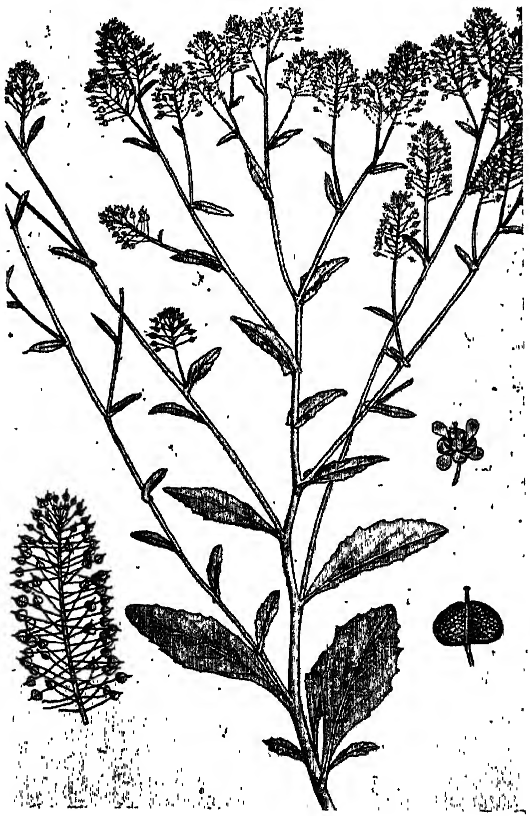

FIG. 23. *Lepidium draba* Linn.

Lepidium draba Linn.

Fl. Brit. Ind., I, 160.

(Hairy Cress)

Vernacular names: AFGHANISTAN—Bijindak; N.-W. F. PROVINCE—Bushk, Buska, Buski.

Botanical characters

A pubescent perennial, 1–3 ft. high. Leaves 1–3 in., oblong, repand-toothed, lower petioled, upper with sagittate auricles. Flowers $\frac{1}{4}$ in. diam., white, in branched panicles. Pod $\frac{1}{6}$ in., deltoid with rounded angles, constricted between the turgid papillose valves of which one is often imperfect; pedicels spreading.

Distribution

A weed of cultivation in the Punjab and N.-W. F. Province.

Toxicity

This plant is stated to be a fish poison (*2*).

Constituents

The seeds yield an essential oil containing sulphur compounds. The young leaves yield hydrocyanic acid (*1*).

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Family IX.—CAPPARIDACEAE

(Caper Family)

Botanical characters

Herbs or shrubs, erect or climbing, rarely trees. Leaves simple or digitately 3–9-foliolate; stipules 2 or 0, sometimes spinescent. Flowers solitary, racemed, corymbose or umbelled, regular or slightly irregular, usually 2-sexual. Sepals 4. Petals 4 (rarely 2 or 0). Stamens usually 6, sometimes 4 or many, sometimes on a gynophore. Ovary usually stalked, 1-celled; ovules numerous, on 2–4 parietal placentas; style short or 0; stigma depressed or capitate. Fruit a pod-like capsule or a berry. Seeds exalbuminous.

Distribution

Chiefly tropical.

Economic and toxic aspects

Members of this family are not usually classed amongst poisonous plants, but many of them contain acrid and pungent principles which have strongly rubefacient properties, and there are no grounds for excluding them from consideration here. Several herbaceous members have therapeutic properties similar to those of the mustard family. Identical properties are found in the root-bark and the leaves of the arboraceous members, the bark of which is usually bitter and laxative. The flower buds of caper (*Capparis spinosa* Linn.) are pickled in Europe. In India the ripe fruits of this plant are eaten either in the raw state or in the form of pickles. The fruits of *C. aphylla* Roth, known as 'delha' or 'karir', are also largely consumed, especially as pickles. The fresh leaves and bark of *Crataeva nurvala* Buch.-Ham. and *C. roxburghii* R. Br. are stated to have vesicant and rubefacient properties. These two species were formerly treated as varieties of *C. religiosa* Forst. *f.* in Indian literature. *C. religiosa*, whose bark contains tannins and also saponins, is not an Indian plant.

KEY TO THE GENERA

A. Shrubs or trees. Fruit baccate. Stamens indefinite, inserted on the torus at the base of the long gynophore 1. *Capparis*.

B. Herbs. Fruit capsular.

- *a*. Stamens sessile on the disc. Petals imbricate in bud 2. *Cleome*.
- *b*. Stamens on the gynophore. Petals open in bud .. 3. *Gynandropsis*.

1. CAPPARIS (Tourn.) Linn.

(From *kapparis*, the Greek name for *C. spinosa* Linn., used by Dioscorides.)

Botanical characters

Trees or shrubs, erect, straggling or climbing, often with stipulary thorns. Leaves simple, rarely 0. Flowers often showy. Sepals 4,

2-seriate, imbricate, or 2 outer subvalvate. Petals 4, not clawed. Stamens indefinite, inserted on the torus at the base of the long gynophore. Ovary stalked, 1–4-celled; stigma sessile. Fruit fleshy, stalked, rarely dehiscing by valves. Seeds many, embedded in pulp.

Distribution — Tropical and warm regions.

Constituents — *C. spinosa* Linn. contains some glucosides and saponins (*1*).

Capparis aphylla Roth

Fl. Brit. Ind., I, 174.

Vernacular names: ARABIC—Hanbag, Margh, Sodab, Tundub; BALUCHISTAN—Kaler, Kalir, Karar, Khirar; BIHAR—Kari; BOMBAY—Kari; DECCAN—Karyal; GUJERAT—Ker, Kera; HINDI—Karel, Karer, Karu, Kurrel, Lete, Satari; KANARESE—Chippuri, Karira; KONKANI—Kiral; MARATHI—Karil, Ker, Nepti, Nevati; PERSIAN—Sodab; PUNJAB—Delha, Kaira, Karil, Karir, Karis, Kerin, Kirra, Pinju, Tenti; SANSKRIT—Karira; SIND—Dora-kiram, Kirab, Kiral, Kirrur; TAMIL—Kulaladondai, Sengam, Sirakkali; TELUGU—Kariramu; UNITED PROVINCES—Kair, Kari, Karil, Pasi (flower-buds); URDU—Titali.

Botanical characters — A glabrous straggling thorny shrub or small tree, leafless or nearly so; twigs smooth, green, often with a waxy bloom. Leaves on young shoots only, less than $\frac{1}{2}$ in. long, linear-oblong, spinous-pointed, pungent, caducous; stipules spinous, nearly straight, often wanting. Flowers $\frac{4}{5}$ in. across, red, rarely yellow, in corymbs on short lateral branches. Stamens 18–20. Berry $\frac{1}{2}$–$\frac{3}{4}$ in. diam., globose, red or pink, on a slender stalk.

Distribution — Found in Cutch, Sind, Baluchistan, West Rajputana, the Punjab, Upper Gangetic Plain, Central India, Gujerat, the Deccan, and Tinnevelly.

Uses and properties — The bark has an acrid, sharp, and hot taste. In the Punjab, the tender shoots and young leaves are used to raise blisters; they are also said to be efficacious in relieving toothache.

2. CLEOME Linn.

(From the Greek *kleio*—to close; the flowers are close set.)

Botanical characters — Herbs. Leaves simple or digitately 3–9-foliolate. Flowers racemose or solitary and axillary, yellow, rose or purple. Petals 4, subequal, sometimes subunilateral, imbricate in bud. Stamens 4–8 or more, sessile on the disc. Ovary sessile or with a very short gynophore. Capsule oblong or linear, 2-valved; valves membranous, separating from the seed-bearing placenta. Seeds reniform.

Distribution — In tropical or warm regions.

FIG. 24. *Capparis aphylla* Roth

Economic and toxic aspects

The seeds are rubefacient, vesicant, and anthelmintic. It is not known to what extent these plants are eaten by livestock in India, but some of the foreign species (2) are occasionally used as forage.

KEY TO THE SPECIES

a. Flowers purple or pink. Capsule glabrous ..	..	1. *C. felina.*
b. Flowers yellow. Capsule glandular-pubescent	..	2. *C. icosandra.*

1. Cleome felina Linn. *f.*

Fl. Brit. Ind., I, 170.

Vernacular name :—MALAYALAM—Ariavila.

Botanical characters

An erect much-branched annual, rough with rigid appressed scale-like hairs. Leaves 3-foliolate; leaflets ½–1 in., obovate, obtuse

Flowers axillary, solitary, $\frac{1}{2}$–$\frac{3}{4}$ in. long, long-pedicelled, purple or pink. Stamens 28–32. Capsule 1–1$\frac{1}{2}$ by $\frac{1}{8}$ in., compressed, acute at both ends, glabrous, striate. Seeds large, glabrous, tubercled.

Distribution

Found in the dry districts of the Deccan and Carnatic, especially in the black cotton soil.

Toxicity

The seeds and the entire plant are rubefacient and vesicant.

2. Cleome icosandra Linn.

C. viscosa Linn., Fl. Brit. Ind., I, 170.

(Sometimes called Wild Mustard)

Vernacular names: ARABIC—Bantakalan; BENGAL—Hurhuria; BOMBAY—Hurhuriya, Kanphuti, Pivala-tilavana; DECCAN—Chorie-ajuvan, Churai-ajvani, Jangli-hulvul; GANGPUR—Kirliggid; GUJERAT—Talvani, Tilvan, Tinmani; HINDI—Hulhul, Hurhur, Hurhurch, Jangli-harrar, Kanphutia, Kanphytia; KANARESE—Naibala; MALAYALAM—Ariavila; Kat-kudagu; MARATHI—Harhuria, Kanphodi; MUNDARI—Marang-karmaniara; PORBANDAR—Pili-talvani; PUNJAB—Bugra, Hulhul; SANSKRIT—Aditya-bhakta, Shunaka-barbara, Svana-burbara; SANTAL—Harhara; SIND—Kattori; TAMIL—Nai-kadugo, Nai-veylai; TELUGU—Kukka-avalu, Kukka-vaminta; URDU—Hulhul.

Botanical characters

Annual, erect, 1–3 ft. high; stem densely clothed with viscid glandular and simple hairs. Leaves 3–5-foliolate; leaflets obovate or elliptic-oblong (when 5-foliolate the basal pair much reduced). Flowers yellow, long-pedicelled. Petals about $\frac{1}{2}$ in. long, reflexed. Stamens 12 or more. Capsule 2–3$\frac{1}{2}$ in. long, glandular-pubescent, striate, compressed, tapering at the apex into a short beak. Seeds brown-black when ripe, finely transversely striate, subglobose.

Distribution

A common weed throughout the greater part of India.

Uses and properties

The seeds of this plant are occasionally used in India in curries, and the leaves are also stated to be eaten as a vegetable. The juice of the leaves is used to relieve earache and when given internally it acts as a sudorific (*1*). The seeds are rubefacient, vesicant, and anthelmintic; the leaves are rubefacient and vesicant. According to Moodeen Sheriff, in India the seeds of *C. icosandra* are considered superior to mustard seeds as a rubefacient and vesicant (*3*). *Gynandropsis gynandra* (Linn.) Merr. (*G. pentaphylla* DC.), another plant of the same family, is frequently found with *C. icosandra*. The two plants are often confused partly on account of a general botanical resemblance between them and partly owing to their vernacular names being almost the same. The close similarity of their seeds adds greatly to the confusion.

Constituents

The seeds contain a sharp essential oil (*4*), and are used as an adulterant of mustard seeds.

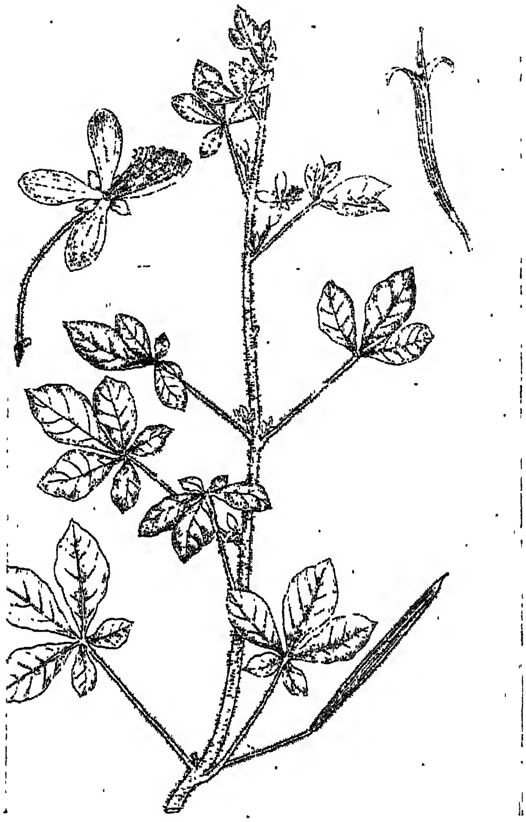

FIG. 25. *Cleome icosandra* Linn.

3. GYNANDROPSIS DC.

(From the Greek *gyne*—a woman, and *aner*, *andros*—a man; referring to the presence of a column—gynandrophore—bearing the ovary and the stamens.)

Botanical characters Annual, glandular-pubescent or glabrate herbs. Leaves 3–7-foliolate, long-petioled. Flowers racemose. Petals 4, spreading, long-clawed, open in bud. Stamens 6, inserted on the long gynophore Ovary stalked. Capsule elongate, stalked. Seeds reniform.

Distribution In tropical regions.

Gynandropsis gynandra (Linn.) Merr.

G. pentaphylla DC., Fl. Brit. Ind., I, 171.

Vernacular names: BENGAL—Ausarisha, Arkahuli, Hulhul. Hurhur, Hurhuria, Kanala. Karaila, Sada-hurhuria. BOMBAY—Mabli, Tilavana; DECCAN—Halhal;

GUJERATI—Adiyakharan, Sati-talvani, Tanmani; HINDI—Churota—Gandhuli, Hulhul, Hurhui, Karalia, Lal-hulhul, Safed-hulhul; MALAYALAM—Kara-vela, Nei-vaylla, Tai-vela, Vela; MARATHI—Kanphodi. Mabli, Moti-tilavan, Pandhari-tilavan, Tilavana; MUNDARI—Karman, Kiarmari, Marang-karmani; PORBANDAR—Dholi-talvani, Gandhari-talvani, Sati-talvani; RAJPUTANA—Pagra: SANSKRIT—Arkapushpika, Surjavarta; SANTALI—Seta-kata-arak; SIND—Kinro; TAMIL—Nai-kadughu, Nai-velai, Velai; TELUGU—Vaminta, Velakura; UNITED PROVINCES—Kathalparhar.

Botanical characters

Strong-smelling, somewhat foetid weed, 1–3 ft. high. Leaves digitate; leaflets 3–5, sessile, unequal, obovate, glandular-hairy.

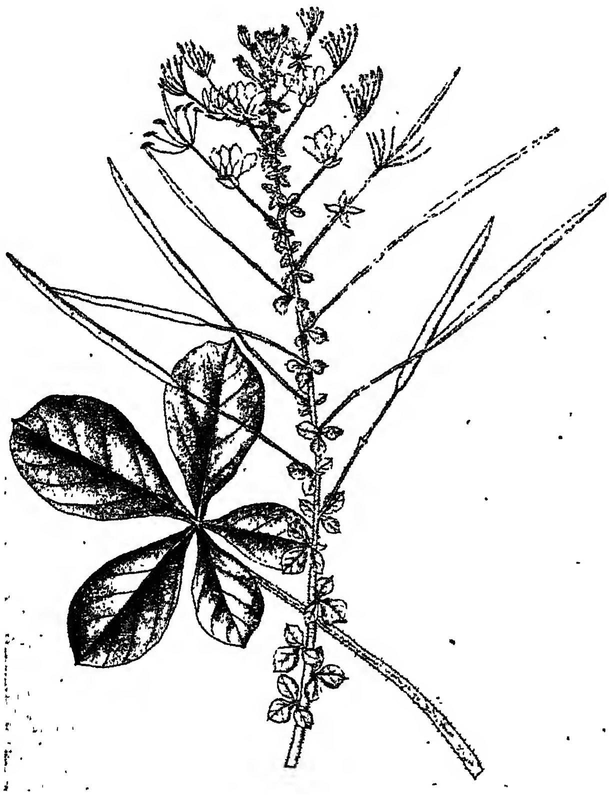

FIG. 26. *Gynandropsis gynandra* (Linn.) Merr.

Flowers purple or white, $\frac{1}{3}$–$\frac{2}{3}$ in. diam., in elongating corymbiform racemes; bracts 3-foliolate. Anthers purple.

Distribution

Abundant throughout the warmer parts of India.

Uses and properties

The leaves and the small kidney-shaped black seeds are used in Indian medicine. The bruised leaves are rubefacient and vesicant, producing a copious exudation on application. The juice of the leaves is also

employed in otalgia and otorrhoea, but produces a burning sensation. The seeds have anthelmintic and rubefacient properties. Rubbed with oil, they are used to destroy head lice. According to Watt (*3*), they are employed to poison fish, but this needs confirmation.

Constituents

When crushed in a fresh state, the herb yields an acrid volatile oil having the properties of garlic or mustard essential oil (*1*). The seeds also contain a sharp essential oil similar to the essential oil of mustard (*4*).

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Family X.—BIXACEAE

(Annatto and Chaulmoogra Family)

Botanical characters

Trees or shrubs. Leaves alternate; stipules small or 0. Flowers 1–2-sexual. Sepals 4–5, rarely 2–6, usually imbricate, rarely connate and splitting irregularly, mostly deciduous. Petals 4–5 or 0, imbricate or contorted in bud, deciduous. Stamens usually indefinite; anthers dehiscing by slits or pores. Ovary usually 1-celled; ovules usually numerous, on several parietal placentas. Fruit dry or fleshy, indehiscent or valvular. Seeds arillate or testa pulpy; albumen fleshy.

Distribution

Chiefly in tropical regions.

Economic and toxic aspects

Chaulmoogra oil, which has been used in Hindu medicine in the treatment of leprosy from very early times, is obtained from *Hydnocarpus kurzii* (King) Warb. (*Taraktogenos kurzii* King) and *H. laurifolia* (Dennst.) Sleumer (*H. wightiana* Blume). During recent years this oil has also come to be recognized in Western medicine as a valuable remedy in the treatment of this same disease. Some species are used as fish poisons and, besides those dealt with hereafter, *Hydnocarpus venenata* Gaertn. of Ceylon and *H. castanea* Hook. *f.* & Thoms. of the Andaman Islands and Tenasserim are used for this purpose. Narcotic and anthelmintic properties are also found to a certain extent in some of the plants.

Bixa orellana Linn., a small evergreen tree, is largely cultivated in India for ornamental purposes and for the red or orange dye known as annatto or arnatto, which is obtained from the pulpy testa of the seeds. The dye is largely used to colour oil, butter, etc.; it contains bixin, a red colouring matter (*1*). The embryo of the seed contains a poisonous principle (*2*).

A few plants of this family supply timber. Some species of *Flacourtia* yield edible fruits, while their leaves are collected for fodder. Bassora gum or 'katira' of commerce is derived from *Cochlospermum gossypium* DC., a small deciduous tree with yellow flowers and pear-shaped fruits, found in Northern, Central, and Western India.

Constituents

The following constituents have been isolated from members of this family: (*a*) *acids*, such as hydrocyanic, chaulmoogric, hydnocarpic etc., and (*b*) *glucosides*, such as gynocardin.

KEY TO THE GENERA

a. Sepals connate. Stamens very many .. .. 1. *Gynocardia.*
b. Sepals free. Stamens 5–30 (in the species here described) 2. *Hydnocarpus.*

1. GYNOCARDIA R. Br.

(From the Greek *gyne*—female, and *kardia*—heart.)

Distribution

One species found in India and Burma.

Gynocardia odorata R. Br.

Fl. Brit. Ind., I, 195.

Vernacular names: ASSAM—Bandarpele, Chaulmugra; BENGAL—Chaulmugra, Chaulmugri, Petarkura; BOMBAY—Chaulmogra; HINDI—Chaulmogra, Chavulmungri, Chhalmugra, Choulmungri; LEPCHA—Tukkung, Tulkung; NEPAL—Bandre, Gante, Kadu, Ramphal; PERSIAN—Brinjmogra; SANSKRIT—Alasakapaha, Kushthapa, Sagarodbhuta, Tuvaraka.

Botanical characters

A glabrous tree. Leaves bifarious, 6 10 by $1\frac{1}{2}$–$3\frac{1}{2}$ in., oblong, abruptly acuminate, rounded or acute at base, entire. Flowers dioecious, pale-yellow, sweet-scented, in few-flowered axillary fascicles or in large bunches (of about 40 flowers) from the trunk, $\frac{1}{2}$–$1\frac{1}{2}$ in. across.

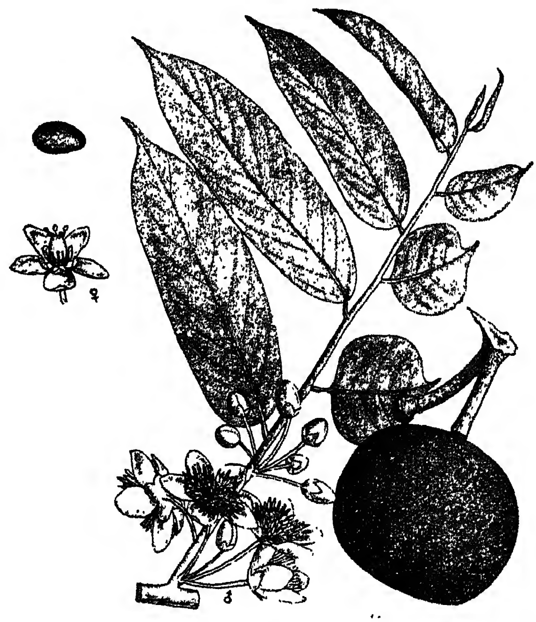

FIG. 27. *Gynocardia odorata* R. Br.

Calyx 5-lobed, leathery, saucer-shaped. Petals 5, each with a basal ciliate scale. Stamens in male flowers about 100, filaments woolly, in females 10–15 staminodes; styles 5. Fruit 3–5 in. across, always on the trunk, globose; rind thick, hard, minutely lenticelled outside. Seeds about 1 in. long, obovoid or oblong; albumen oily.

Distribution

Common in the evergreen forests of Sikkim and Assam, extending south-eastwards across Chittagong as far as Tenasserim.

Toxicity

The seed pulp is employed in Sikkim to poison fish.

Constituents

The seeds freed from the shell yield about 65 per cent of a fatty oil, known as gynocardia oil. This oil does not contain any chaulmoogric acid or its homologue, but consists of glycerides of linolic, palmitic, linolenic, *iso*linolenic, and oleic acids. It is stated to have no value in leprosy. The seeds also contain a cyanogenetic glucoside, gynocardin [5 per cent of shell-free seeds (*3*)].

2. HYDNOCARPUS Gaertn.

(From the Greek *hydnos*—a tuber, and *karpos*—a fruit; in reference to the rough and hard fruits.)

Botanical characters

Trees. Leaves penninerved; stipules deciduous. Flowers solitary, fascicled, racemose or cymose, dioecious. Sepals usually 4–5, free, imbricate, sometimes united at the base. Petals 4-5 or up to 14, with a basal scale opposite each. Male flowers: Stamens 5–numerous. Ovary 0 or rudimentary. Female flowers: Smaller than the male. Stamens as in the male but without pollen, or reduced to staminodes. Ovary 1-celled; stigmas 3–6, sessile or subsessile, spreading, dilated, lobed; ovules many, on 3–6 parietal placentas. Berry globose, usually many-seeded; rind hard. Seeds embedded in pulp; testa crustaceous, striate or not; albumen oily.

Distribution

In tropical Asia.

Chaulmoogra oil

The seeds yield an oil which is largely used in medicine. Chaulmoogra oil of the B. P. C. and U. S. P. XI (hydnocarpus oil of B. P. 1932) is obtained by cold expression from *H. laurifolia* (Dennst.) Sleumer (*H. wightiana* Blume), *H. kurzii* (King) Warb. (*Taraktogenos kurzii* King), and other species of *Hydnocarpus*, provided the oil agrees with the specifications laid down. It contains glycerides of chaulmoogric and hydnocarpic acids and their lower homologues along with those of other fatty acids.

The oil is obtained from the chaulmoogra or hydnocarpus seeds by hot or cold extraction. The seeds yield 30 to 40 per cent of the oil, according to the method used. By hydraulic pressure about 30·9 per cent of the oil is obtained, while by ether extraction the yield amounts to 38·1 per cent. The pure oil is of a pale-yellow or a reddish-brown colour, but that sold in the market is usually rancid, dark brown and devoid of any therapeutic value. On hydrolysis, the fatty oil yields fatty acids which are mixtures of several constituents; these can be separated by fractionation, yielding: (*a*) chaulmoogric

acid, (*b*) hydnocarpic acid, (*c*) some lower homologues of chaulmoogric acid, and (*d*) palmitic acid, oleic acid, etc.

Pharmacological action

Chaulmoogra oil itself has very little bactericidal property as it cannot easily penetrate the bacterial cell wall. It possesses, however, a definite bacteriostatic action, as is evidenced by the fact that the addition of the oil (2 per cent) to culture media, inhibits the growth of acid-fast bacilli, such as tubercle bacilli. Derivatives of the oil, on the other hand, are more active. Sodium salts of the total fatty acids—chaulmoogrates—are said to possess a high degree of bactericidal and bacteriostatic activity against tubercle bacillus *in vitro* in such dilutions as 1 in 100,000. This action is said to be specific, as it is not present in the case of such closely related fatty acids as those occurring in cod-liver oil, etc. Suspensions of virulent tubercle bacilli are said to be rendered harmless to guinea pigs by incubation for 48 hours with any of the acid sodium salts or the esters of the fatty acids of chaulmoogra oil. The esters are found to have no inhibitory effect on *Staphylococcus albus* and other allied organisms.

Chaulmoogra oil is extremely irritating by whichever route it is administered. Oral administration of 3 to 4 drops of the oil produces nausea and vomiting, but it is possible to develop a tolerance to it so that as much as 15 minims can be taken in a single dose. Not only the oil, but the sodium salts of the fatty acids as well as the esters have powerful irritant actions. The injection of these products into the tissues is painful and may give rise to local abscesses. The systemic effects produced by chaulmoogra-oil derivatives are, however, not very marked.

Therapeutic uses

Chaulmoogra has long been used in India in certain skin diseases, particularly as a remedy for leprotic lesions of the skin. Originally chaulmoogra seeds were given by mouth, but this was found to be unsatisfactory and so the oil expressed from the seeds began to be used. Oral administration of both the seeds and the oil produces nausea and vomiting, and cannot be continued for a long time. It has, therefore, been largely discarded in favour of the intramuscular and intravenous administration of the drug.

As the oil itself is very irritant, Mercado tried to produce a preparation which would prove less irritant to the tissues (*4*). He used a mixture of 60 c. c. of chaulmoogra oil, 60 c. c. of camphorated oil to deaden pain, and 4 gm of resorcin as an antiseptic. Heiser (*5*) treated a small series of cases with this mixture and reported 11·1 per cent of apparent cures. This treatment has now been largely abandoned as patients refuse to submit to it on account of the pain it produces at the site of injection. Sudhamoy Ghosh, working in India with Rogers, first suggested the use of ethyl esters of chaulmoogric acid and of

hydnocarpic acid, and prepared esters from the pure acids for this purpose. The subcutaneous injections of these pure esters were, however, found to be irritating to the tissues and their use was discontinued for some time (*6*). In 1919, Dean (*7*) prepared the ethyl esters of the "total fatty acids" of chaulmoogra oil, and reported encouraging results with subcutaneous injections. McDonald (*8*) was, however, more successful and treated a number of cases with the ethyl esters of the entire fatty acids of the whole oil with 2 per cent iodine by weight, chemically combined. The results which followed this method were very satisfactory and were unattended by pain or abscess formation. In India, Muir (*4*) has largely used the ethyl esters.

Sodium salts of fatty acids

Rogers (*9*) used the sodium salts of the fatty acids of chaulmoogra oil. These sodium salts were found to be soluble in water and their toxicity was also low, so that they could be injected intravenously without any danger to the patients. Later, it was observed that salts of higher-melting fatty acids were more irritant and painful, and Rogers, attempting to do away with this drawback, advocated the use of the less irritating salts of the lower-melting fatty acids of the oil. As a result of this suggestion, a sodium salt of the lower-melting fatty acids, known as "alepol," has been prepared. The pharmacological action of this salt has been studied by Dikshit and its toxicity has been found to be low. Its irritant effects can be considerably decreased when it is combined with serum or administered in Locke's solution (*10*).

KEY TO THE SPECIES

a. Sepals 4. Stamens 20–30 .. .. .. 1. *H. kurzii*.
b. Sepals 5. Stamens 5 .. .. .. 2. *H. laurifolia*.

1. Hydnocarpus kurzii (King) Warb.

Taraktogenos kurzii King

Vernacular names: ASSAM—Lamtem, Lemtam; BURMA—Kalanzo, Kalaw, Kalawaso, Kalawni, Kalawso; LEPCHA—Tukakunga.

Botanical characters

A tree up to 50 ft. high. Leaves mostly lanceolate-oblong, 7–9 in. long, cuneate at base; petiole swollen and slightly geniculate at the upper end. Flowers $\frac{1}{3}$–$\frac{1}{2}$ in. across, pale-yellow, inodorous, in few-flowered axillary cymes, dioecious, a few hermaphrodite on male trees. Male flowers: Sepals 4. Petals 8, ciliate, each with a fleshy pubescent gland at the base. Stamens 20–30. Fruit chocolate-brown, 3–2$\frac{1}{2}$ in. across, globose; rind plain but scurfy, rather velvety. Seeds 12–30, about 1 in. long, faceted.

Distribution

Common in the evergreen forests of Upper Assam and Chittagong.

Uses and properties

The seeds of this species along with those of *H. laurifolia* are the chief sources of chaulmoogra oil. *H. kurzii*, however, is found in

out-of-the-way places where its seeds cannot be gathered easily during the rainy season when the fruits fall, and, in consequence, it is not easy

FIG. 28. *Hydnocarpus kurzii* (King) Warb.

to get fresh seeds for extraction of the oil. For this and other reasons the oil is usually extracted from *H. laurifolia*.

The hill tribes in Sikkim use the pulp of the fruit to poison fish, and sometimes also as food after boiling with water (*4*). The bark of the tree is said to be used as a febrifuge; it contains a large percentage of tannin, and an infusion made from it has the odour of the essential oil of bitter almonds (*4*).

Constituents

The fresh seeds contain hydrocyanic acid, the yield being about 0·036 per cent of the kernels. The yield of fatty oil amounts to about 38 per cent of the entire seeds and consists of the glycerides

of chaulmoogric acid, hydnocarpic acid and their lower homologues together with some palmitic acid (*11*). Later investigations have shown the presence of other acids, such as taraktogenic acid, *iso*gadoleic acid, and probably arachidic acid (*12*).

2. Hydnocarpus laurifolia (Dennst.) Sleumer

H. wightiana Blume, Fl. Brit. Ind., I, 196.

Vernacular names: BOMBAY—Kauti, Kava; DECCAN—Jangli-badam (seeds); GOA—Kosto; KANARESE—Bhutahi, Garuduphala, Niradi-vittulu, Suiante, Toratti; KONKANI—Konstel, Konxtti; MALAYALAM—Kodi, Koti, Maravetti, Maroti, Niralam, Nirvetti, Tamana, Vetti; MARATHI—Kobasel, Kadu-kavata, Kantel, Kastel, Kiti, Kowti; SANSKRIT—Garudaphala; TAMIL—Maravattai, Maravetti, Niradi-muttu; TELUGU—Adavi-badamu, Niradi, Niradi-vettulu (=seeds); TULU—Surante.

Botanical characters

A tree 30–50 ft. high. Leaves 4–10 in. long, oblong, rarely elliptic-oblong, more or less serrate, apex shortly subcurvate-acuminate. Flowers solitary or subcymose. Male flowers: Sepals 5, pubescent

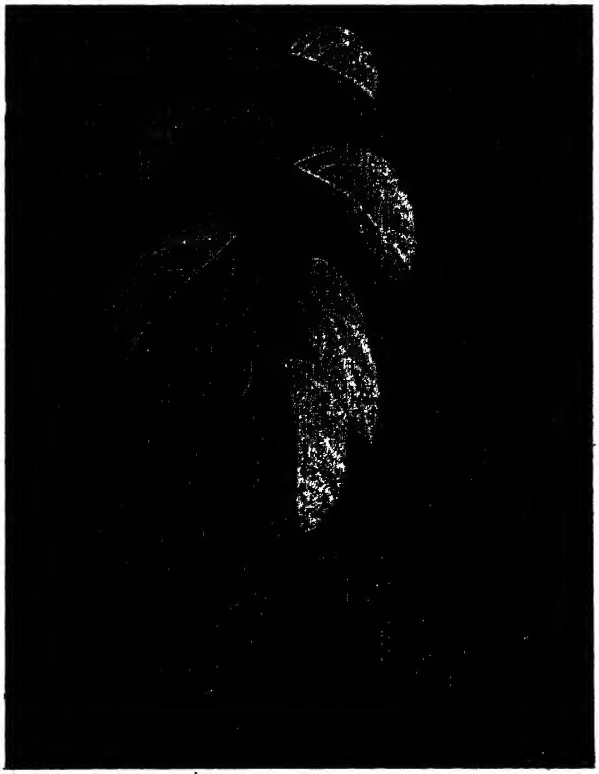

FIG. 29. *Hydnocarpus laurifolia* (Dennst.) Sleumer

outside. Petals 5, glabrous, greenish-white, margin fimbriate. Scales as long as petals, densely ciliate. Stamens 5. Fruit globose, 2–4 in. diam., tomentose, mammillate. Seeds 15–20, about $\frac{4}{5}$ in. long, subovoid, obtusely angular, striate.

Distribution

Common in Western India; endemic in tropical forests along the Western Ghats from the Konkan southwards and below the Ghats in Kanara and Malabar, in damp situations especially near water. In Travancore it is common up to an altitude of 2,000 ft.

Chaulmoogra oil

The seeds yield by expression or on boiling in water about 44 per cent of yellowish-coloured, somewhat acrid oil called chaulmoogra oil (*13*). The oil consists of glyceryl esters of chaulmoogric acid, hydnocarpic acid and some of their lower homologues. The seeds have not been found to contain any cyanogenetic compound (*14*).

Toxicity

The seeds or the oil if taken internally act as a gastro-intestinal irritant, producing vomiting and purging (*13*). Oral administration of 3 to 4 drops of the oil produces nausea and vomiting, although in the treatment of leprosy it has been possible to develop tolerance to as much as 15 minims in a single dose. Not only the oil, but the sodium salts of the fatty acids as also the esters have powerful irritant action. This is why oral administration has been largely discarded in favour of intramuscular and intravenous administration of this drug. Injection into the tissues is painful and may give rise to local abscesses (*4*). About ten per cent of the patients develop skin eruptions or fever which, however, disappear in due course.

The fruit is said to be used as a fish poison.

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Family XI.—POLYGALACEAE

(Milkwort Family)

Botanical characters

Usually herbs, sometimes shrubs, rarely trees. Leaves alternate (rarely whorled) or occasionally scaly or 0, simple, exstipulate. Flowers irregular, 3-bracteate. Sepals 5, unequal, 2 inner (wings) often petaloid and larger. Petals 5 or 3, unequal, the inferior usually keel-shaped. Stamens usually 8, rarely 4–5, hypogynous, monadelphous, rarely distinct; anthers usually opening by terminal pores. Ovary free, 1–3-celled; style generally curved; stigma capitate; ovules 1 or more. Fruit generally a 2-celled, 2-seeded, loculicidal capsule, or indehiscent, or of 3 indehiscent carpels. Seeds pendulous, usually strophiolate and albuminous.

Distribution

All over the world except New Zealand, Polynesia, and the Arctic zone; chiefly in warm regions.

Economic and toxic aspects

Some of the plants of this family have expectorant, bitter, and emetic properties; a few are acrid and poisonous. Saponins occur in a number of plants. Some of the species yield a strong fibre.

POLYGALA (Tourn.) Linn.

(From the Greek *polys*—much, and *gala*—milk; the plants grow in pastures and were supposed to increase the yield of milk in cows.)

Botanical characters

Herbs, rarely shrubs. Leaves alternate. Flowers papilionaceous with the "wings" formed of the two inner, larger, usually petaloid and persistent sepals. Petals 3, united at the base with the staminal sheath, the inferior keeled and generally crested. Stamens 8; filaments united for their lower half into a split sheath. Ovary 2-celled. Capsule 2-celled, loculicidal, 2-seeded.

Distribution

Almost cosmopolitan.

Economic and toxic aspects

Members of this genus possesses tonic, expectorant, and emetic properties. *P. senega* Linn. (senega, seneka) is a foreign plant whose roots are officinal in all pharmacopoeias. Some Indian species of *Polygala* possess properties similar to this plant. From analyses of the Indian species *P. chinensis* Linn., *P. crotalarioides* Buch.-Ham. *ex* DC., and *P. telephioides* Willd., the authors of the "Pharmacographia Indica" conclude that these plants owe their medicinal properties to the presence of a substance closely related to, if not identical with, the saponins from *P. senega*. *P. javana* DC. of the Madras Presidency has also been stated (*1*) to contain saponin.

Senega

Millspaugh, as quoted by Pammel (*1*), states : " After tasting the tincture or chewing the rootlets," of *P. senega* " a very peculiar sensation of acridity and enlargement is felt at the root of the tongue, which, once recognized, will always mentally associate itself with this plant."

According to the author quoted above, in doses of 10 minims of the tincture to a scruple of the powdered root, it produces : " Anxiousness, with dullness of the head and vertigo ; aching and weakness of the eyes, with lachrymation, pressure in the ball, flickerings, dazzling vision, and contracted pupils ; sneezing ; ptyalism ; inflammation of the fauces and oesophagus, with thirst with anorexia ; nausea ; mucous vomiting ; burning in the stomach ; cutting colic ; roughness and irritation of the larynx, with orgasm of blood to the chest, accompanied by constriction, aching, soreness, and oppression ; general debility ; restless sleep ; and profuse diaphoresis."

Fresh roots contain 10 per cent and old roots only 2 per cent of haemolytic saponins, senegon and senegin (*2*). The fresh roots are also known to contain small quantities of an essential oil containing about 1·6 per cent of methyl salicylate and methyl baldrianate (*3*).

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Family XII.—CARYOPHYLLACEAE

(Pink and Carnation Family)

Botanical characters

Herbs, rarely undershrubs; branches opposite, generally thickened at the nodes. Leaves simple, opposite, bases often more or less united; stipules scarious or 0. Inflorescence usually a dichotomous cyme. Flowers rarely 1-sexual. Sepals 4 or 5, imbricate. Petals 4–5, often clawed, generally bifid, rarely 0. Stamens 8–10, rarely fewer, inserted with the petals. Disc small and annular, or elongated into a gynophore, or broken up into glands. Ovary free, 1-celled or imperfectly 3–5-celled, with free-central placentation; styles 2–5, free or connate. Capsule membranous or crustaceous, rarely fleshy, opening by valves equal in number or double that of the styles, rarely indehiscent or bursting irregularly. Seeds often reniform, albuminous.

Distribution

Cosmopolitan; chiefly in extratropical regions of the Northern Hemisphere.

Economic and toxic aspects

Several members of this family are cultivated for ornamental purposes. Pinks and carnations (*Dianthus* sp.) are found in gardens all over India, especially in the hills, and *D. chinensis* Linn. (China pink) is practically a weed of cultivation. *Gypsophila* and common pink catchfly (*Silene armeria* Linn.) are other common garden plants. Many members of the family, especially those belonging to the genera *Saponaria*, *Lychnis*, *Arenaria*, *Herniaria*, *Dianthus*, *Polycarpaea*, *Gypsophila* and *Agrostemma*, contain saponins. Soapwort or cowherb (*Saponaria vaccaria* Linn.) found in India is well known and contains 8 to 15 per cent of saponins. The seeds of the foreign plant *Agrostemma githago* Linn. contain the sapotoxin githagin, and are reported to have been responsible for many cases of poisoning among poultry, household animals, and human beings. They get mixed up with the normal food, especially flour, and produce acute or chronic irritation of the gastro-intestinal tract. The sapotoxin is partially decomposed during baking; nevertheless, it is suggested that food containing the same should be rejected. Chickweed [*Stellaria media* (Linn.) Cyrill.] is a very common weed throughout the Punjab and the temperate regions of India up to an altitude of 14,500 ft. in Tibet. Watt (*1*) states that the leaves and tender shoots, after boiling in 'khar' water, are eaten by the inhabitants of certain parts of Assam. Pammel (2) states that the seeds of this plant are used as a food for birds, but adds that they cause disorder of the digestive system when eaten in large quantities by lambs. We deal here in detail only with *Saponaria vaccaria*, the better known of the Indian members of this family.

The plants of this family have a slightly bitter taste, and the seeds and roots are usually acrid.

Constituents

Plants of most of the genera of this family contain saponins.

SAPONARIA Linn.

(From the Latin *sapo*—soap; the leaves and roots of some species are boiled and used as soap.)

Botanical characters

Herbs. Leaves flat. Flowers in dichotomous cymes. Calyx more or less tubular, 5-toothed, nerves obscure. Petals 5, clawed. Stamens 10. Ovary 1-celled or imperfectly 2–3-celled; styles mostly 2. Capsule opening at the apex by 4 teeth or short valves. Seeds reniform or subglobose, hilum marginal.

Distribution

In north temperate regions, chiefly Mediterranean.

Uses

The leaves of some of the members of this genus are commonly used as a resolvent in the treatment of boils and itch.

Constituents

The species of *Saponaria* are rich in saponins. The roots of *S. officinalis* Linn., a foreign plant, contains about 5 per cent of saponins consisting of saponaria-sapotoxin and saporubinic acid. The leaves are also stated to contain saponins (*3*), which have an ascending value in the leaves, roots, and flowers. In the plant, the saponin content increases with its development; the twigs either have none at all or only an extremely low saponin content (*4*). Cases of animal poisoning by this plant are not recorded in literature, but there can be no doubt that, if eaten in excess, it will cause gastro-intestinal irritation, producing vomiting, purging, and inflammation of the alimentary canal.

Saponaria vaccaria Linn.

Fl. Brit. Ind., I, 217.

(Cowherb, Soapwort)

Vernacular names: BENGAL—Sabuni; HINDI—Musna; PERSIAN—Gafis, Guli-gafas; SANTAL—Musna; SIND—Musna.

Botanical characters

A tall, robust, glabrous annual, 1–2 ft. high. Leaves 1–2½ by ¼–¾ in., sessile; the lower oblong, acute; upper oblong-lanceolate. Flowers rosy, in corymbose dichotomous cymes. Calyx ½ in. long, ventricose in fruit, with 5 broad green nerves and scarious margins; teeth triangular. Petals obovate, slightly emarginate; claw shortly exserted; limb ½ in. long. Capsule included, broadly ovoid. Seeds globose, black, granulate.

Distribution

A weed of cultivation met with in wheat fields throughout India and Tibet.

Uses and properties

The properties of this plant are in every respect identical with those of *S. officinalis* the soapwort of Dioscorides. It has been stated to have

febrifugal properties, and that animals generally refuse to eat its seeds. They contain a considerable quantity of a toxic substance ; extracts

FIG. 30. *Saponaria vaccaria* Linn.

from small amount of seeds have been stated to produce illness or death of rabbits.

This plant contains 8 to 15 per cent of saponins, and the mucilaginous sap is used in India as a substitute for washing soap. *Constituents*

Sohn states that the saponin has a burning taste, producing a violent sensation ; the toxic substance is partially removed by baking (*2*).

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Family XIII.—HYPERICACEAE

(St.-John's-wort Family)

Botanical characters

Herbs or shrubs, rarely trees. Leaves opposite, often gland-dotted, entire or gland-toothed, exstipulate. Flowers solitary or cymose, terminal (rarely axillary). Sepals and petals 5 each, rarely 4; petals contorted in bud. Stamens usually indefinite, in 3–5 bundles, rarely free or all connate. Ovary 1- or 3–5-celled; styles as many, filiform, free or united; ovules few or many, on axile or parietal placentas. Fruit capsular or baccate. Seeds exalbuminous.

Distribution

In temperate climates and mountains of warm regions.

Economic and toxic aspects

Some species of *Hypericum* are cultivated as ornamental shrubs. Of these, *H. chinense* Linn. is cultivated in gardens in the plains and has the styles united almost to the top. *H. perforatum* Linn. and others, when dried and boiled in alum, impart a yellow or yellowish-red colour to wool, silk, etc. This plant has been stated to be toxic to livestock if eaten in excess, and, under certain conditions, to lead to photosensitization and consequent dermatitis of the unpigmented portions of the skin.

Many members of this family have balsamic resinous yellow juices, and are used as bitters, purgatives, astringents, and febrifuges.

HYPERICUM Tourn. *ex* Linn.

(The classical name of some species of the genus used by Dioscorides; said to be from the Greek *hyper*—above, and *eikon*—an image, because the stamens stand like a figure.)

Botanical characters

Leaves usually sessile. Flowers yellow. Sepals 5. Petals 5, usually oblique. Ovary 1-celled with 3 or 5 parietal, or 3–5-celled with axile placentas. Capsule septicidal, or dehiscing through the placentas when 1-celled. Seeds not winged.

Distribution

Chiefly in temperate regions.

Hypericum perforatum Linn.

Fl. Brit. Ind., I, 255.

(Perforated St.-John's-wort, St.-John's-wort)

Vernacular names: HINDI and PUNJABI—Bassaut, Dendlu; URDU—Balsana.

Botanical characters

A perennial herb. Stems 1–2 ft., 2-angled. Leaves oblong or ovate-oblong, $\frac{1}{3}$–1 in., obtuse, dotted. Flowers 1 in. diam., in terminal corymbs. Sepals narrowly lanceolate, acute, $\frac{1}{4}$ in., entire. Petals black-

FIG. 31. *Hypericum perforatum* Linn.

dotted on the margins. Stamens in 3 bundles; anthers black-dotted. Ovary 3-celled; styles 3, as long as or twice the ovary. Capsule $\frac{1}{3}$ in.

Distribution Found in the temperate Western Himalayas from Kumaon, between 6,000 to 9,000 ft., to Kashmir at altitudes between 3,000 to 6,500 ft.

Uses This herb is used in indigenous medicine as an astringent, aromatic, purgative, anthelmintic, emmenagogue, and in the treatment of diarrhoea.

Toxicity It has been reported by several investigators that the plant in the flowering stage, if eaten in excess by livestock, leads to a photosensitization and consequent dermatitis of the unpigmented portions of the skin. Animals having pigmented skins or those not exposed to bright sunlight do not develop any symptoms, but white-skinned horses, cattle, and sheep develop characteristic symptoms if exposed to sunlight. The toxic substance, it appears, acts upon the nerve endings so as to photosensitize them, and if the animal is subsequently exposed to strong sunlight it develops dermatitis, including blistering of the skin and falling off of the hair. The animals, however, are not likely to eat much of it voluntarily, because of its bitter, somewhat saline taste and a resinous odour when crushed. The danger from this plant, therefore, appears to be very little under field conditions, except when the animals are starved and no other fodder is available.

Constituents The herb contains tannins and 0·065 per cent of an essential oil consisting of olefinic terpenes, pinene, sesquiterpenes, etc. (*1*).

H. crispum Linn., a foreign species, contains a red amorphous photo-toxic substance —0·16 gm in 100 gm of dry plant (*2*).

Symptoms According to Summers (*3*), it is injurious to horses causing them to develop sores, while it gives milch cows a tendency to go dry. The symptoms in mares as described by Müller (*4*) are: dullness, sinking of the head, loss of appetite, slowing of the pulse and respiration, dilatation of the pupils, defective sight and purple lips.

Prevention It has been suggested that animals should not be allowed to graze on the plant in bright sunlight.

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Family XIV.—GUTTIFERAE

(Gamboge and Mangosteen Family)

Botanical characters

Trees or shrubs with yellow or greenish resinous juice. Leaves opposite, usually evergreen and coriaceous, rarely whorled or stipulate. Flowers often showy, white, yellow or red, 1–2-sexual, sometimes dioecious. Sepals 2–6, imbricate or in decussate pairs. Petals 2–6, usually much imbricated or contorted. Male flowers: Stamens usually indefinite; filaments 1–6-adelphous or quite free; anthers dehiscing by pores or slits or circumsciss. Female flowers: Staminodes various. Ovary 1–many-celled; style usually short or 0, rarely 2; stigmas free or connate, sometimes peltate; ovules 1 or 2 or many, axile or basal and erect. Fruit usually baccate. Seeds large, frequently arillate, exalbuminous.

Distribution

Throughout the tropics, chiefly in America and Asia.

Economic and toxic aspects

The plants of this family are remarkable for yielding yellow or greenish gum resins with emetic and cathartic properties. The best-known resin is the gamboge of commerce, obtained from *Garcinia morella* Desr. The seeds are mostly oleaginous and the oils and fats are used medicinally. Some of the barks have diuretic properties. Many plants yield useful timber. Fruits of several species of *Garcinia* are edible. Of these, the mangosteen (*G. mangostana* Linn.) is well known and is cultivated, especially in Madras and Bengal. The aril of the seed of this plant is a delicacy. Alexandrian laurel (*Calophyllum inophyllum* Linn.) is cultivated as an ornamental tree in India, especially near the seacoast. It is stated to be poisonous to fish. *Mesua ferrea* Linn., a middle-sized tree, yields an extremely hard wood (ironwood), and is often planted near the temples for its fragrant white flowers. The flower buds of *Ochrocarpos longifolius* Benth. & Hook. *f. ex* T. Anders. ('nagkesar') are used for dyeing silk. The fruits of *Garcinia indica* Choisy (wild mangosteen) are eaten and used for making syrup; the seeds yield a concrete oil known as kokum oil (kokum butter when semi-solid), which is used as a substitute for cod-liver oil in India, and also in indigenous medicine for healing chaps and abrasions.

KEY TO THE GENERA

a. Ovary 1-celled, 1-ovuled; style 1, distinct; stigma peltate .. 1. *Calophyllum.*
b. Ovary 2–12-celled; cells 1-ovuled; style short or 0 .. 2. *Garcinia.*

1. CALOPHYLLUM Linn.

(From the Greek *kalos*—beautiful, and *phyllon*—a leaf; the leaves are shining and have numerous slender transverse parallel veins, giving the plants a beautiful appearance.)

Botanical characters

Trees. Leaves opposite, shining, coriaceous, with innumerable parallel slender nerves at right angles to the midrib. Flowers polygamous, panicled. Sepals and petals 4–12, imbricate in 2–3 series. Stamens numerous, filaments slender, often flexuous. Ovary 1-celled; style slender; stigma peltate; ovule solitary, erect. Fruit a drupe.

Distribution

Chiefly in the tropics of the Old World.

Calophyllum inophyllum Linn.

Fl. Brit. Ind., I, 273.

(Alexandrian Laurel)

Vernacular names: BENGAL—Punnag, Sultan-champa; BOMBAY—Udi, Undi; BURMA—Peng-nyet, Pong-nyet, Phouniya, Phung-nyet, Pon-nyet; CUTCH—Udi; DECCAN—Surfan, Surpanda, Surpanka, Undi; HINDI—Sultana-champa, Surpan, Surpunika, Undi; KANARESE—Honne, Huhonne, Nameru, Pinekai, Ponne, Surabune, Surahonne, Vuma; KONKANI—Unddi; MALAYALAM—Bintangor, Pinna, Ponna, Punna; MARATHI—Nag-champa, Pumag, Surangi, Undag, Undela, Undi, Vundi; SANSKRIT—Nameru, Punnaga, Purasakeshara, Surangi, Tungakeshara; SIND—Duggerphul, Dugurphort, Purraya, Purreya, Surangi, Undi; TAMIL—Pinnai, Punnagam, Punnai; TELUGU—Nameru, Puna, Punnagamu, Punas, Punnaga; TULU—Ponne; URIYA—Polang, Punang, Punnango.

Botanical characters

An exceedingly handsome moderate-sized tree with bright-green juice (of the resin canals). Leaves 4–8 in. long, glabrous, shining, oblong,

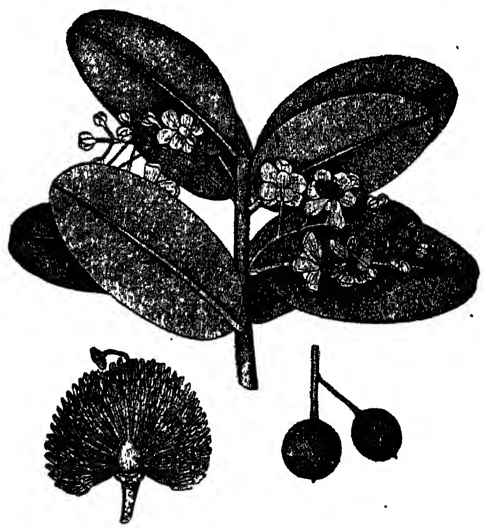

FIG. 32. *Calophyllum inophyllum* Linn.

elliptic-oblong or obovate-oblong, obtuse or emarginate. Flowers $\frac{3}{4}$ in. diam., white, fragrant, in axillary lax drooping racemes 4–6 in. long.

Sepals 4, inner petaloid. Petals 4. Stamens in 4 bundles. Drupe globose, 1 in. diam., yellow and pulpy when quite ripe.

Distribution

Cultivated throughout India, especially near the sea, as an ornamental tree.

Uses and properties

There is considerable doubt with regard to the medicinal properties of the gum. The oil obtained from the kernel is greatly esteemed in India for external application in rheumatism and skin diseases. The plant, according to Pammel (*1*), is a fish poison and contains saponins.

2. GARCINIA Linn.

(In honour of Dr. *Garcin*, a French botanist and traveller.)

Botanical characters

Trees, usually with yellow juice. Stipules usually 0. Flowers polygamous. Sepals 4–5. Petals 4–5, imbricate. Male flowers: Stamens many, free or variously connate; anthers sessile on the staminal column or on short thick filaments. Female or hermaphrodite flowers with free or connate staminodes. Ovary 2–12-celled; stigma sessile or subsessile, peltate, lobed or entire; ovule one in each cell, axile. Berry with a tough rind. Seeds with a pulpy aril.

Distribution

In tropics of the Old World.

Medicinal and toxic aspects

The gum resins are powerful cathartics. Only one species is dealt with hereafter, but it is probable that several others have more or less similar properties. The gum resin from *G. morella* Desr., an Indian species, and *G. hanburyi* Hook. *f.*, a foreign plant, is the true gamboge of medicine and arts. The bark and rind of the fruit of some species are astringent.

Garcinia morella Desr.

Fl. Brit. Ind., I, 264.

(Gamboge Tree)

Vernacular names: Assam—Kuji-thekera; Bengal—Tamal; Burma—Tha-men-gut; Hindi—Tamal; Kanarese—Aradala, Arasina-gurese, Arsina-gurgi-mara, Devanahuli, Jarize, Jarigehuli, Kankutake, Nardala, Punarapuli; Malayalam—Chigiri, Daramba, Karukkampuli, Makki, Pinnarpuli, Pulinjakka, Valakkanna, Valogam; Marathi—Tamal; Sanskrit—Amritadruma, Kalaskandha, Kalatala, Lokaskandha, Mahabala, Niladwaja, Nilátala, Tama, Tamala, Tapichcha, Tapinja, Tapitha; Tamil—Irevalsinni, Makki, Solaippuli; Telugu—Pasupuvarna, Revalchinni; Tulu—Jarige, Jarigepuli, Kanakotekay.

Botanical characters

A medium-sized tree with spreading branches. Leaves 3–5 by $1\frac{1}{2}$–$2\frac{1}{2}$ in., elliptic-obovate to ovate-lanceolate, narrowed at the base. Flowers tetramerous; petals a little larger than the sepals. Male flowers axillary, in fascicles of 2–5, subsessile, or on pedicels $\frac{1}{8}$–$\frac{1}{4}$ in. long. Stamens 25–40, monadelphous, the filaments combined into a subquadrangular

central column, but free at the apex ; anthers orbicular, flattened, dehiscing transversely. Female flowers larger than the male, solitary, axillary,

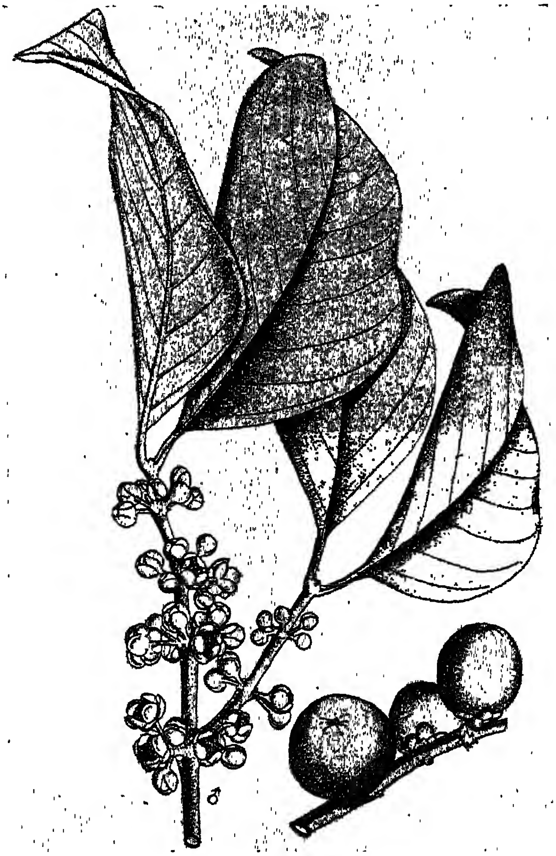

FIG. 33. *Garcinia morella* Desr.

usually sessile. Staminodes 18–30. Ovary smooth, 4-celled ; stigma peltate, irregularly lobed and tubercled. Fruit $\frac{3}{4}$ in. diam., subglobose, slightly 4-lobed, surrounded at the base by the persistent sepals. Seeds 4, ovoid-reniform.

Distribution

An evergreen tree found in the forests of Eastern Bengal, the Khasia Hills, and the Western Ghats from Kanara and Mysore to Travancore.

Uses and properties

This species produces the true gamboge used in medicine and arts ; it is a gum resin obtained from the plant by making a spiral incision in the bark, but is rarely, if at all, collected in India. Gamboge is a

tawny or brownish-orange substance with an acrid taste. and forms a yellow emulsion with water. Several other species of *Garcinia* yield almost similar resins, but of inferior quality (*2*). Gamboge is a hydragogue and drastic cathartic ; in large doses it is a violent gastro-intestinal irritant, and should be administered with caution. In doses of one to five grains it acts as a drastic purgative, and one drachm has caused death. A case, however, is reported in Bombay in which a girl aged 19 swallowed three drachms to commit suicide. but recovered under treatment (*3*). It is stated to be largely used by quacks and forms one of the chief ingredients of their vegetable pills. It is stated that the gum resin has been known to prove fatal when used in large doses as a purgative or as an abortifacient.

Gamboge contains 70 to 80 per cent of resin, 15 to 20 per cent of gums, and a small quantity of vegetable debris. The resin consists of several resin acids named as "garcinolic acid", also esters and a neutral resene (*4*). These acids form readily-soluble compounds with alkalis and thus become active in the intestines. The effects resemble those of colocynth.

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Family XV.—TERNSTROEMIACEAE

(Tea Family)

Botanical characters

Trees or shrubs. Leaves alternate, simple, usually coriaceous, exstipulate. Flowers usually showy and subtended by 2 sepal-like bracts, axillary, solitary or clustered, rarely on many-flowered peduncles. Sepals 5, rarely 4–7, free or slightly connate, imbricate. Petals 5, rarely 4–9, imbricate or contorted, free or connate below. Stamens indefinite, rarely 5, 10 or 15, free or connate by their filaments into 1 or several bundles, usually adnate to the base of the deciduous corolla. Ovary superior, rarely half-inferior, usually 3–5-celled ; styles as many, free or connate ; ovules 2–many in each cell, rarely solitary. Fruit baccate or capsular. Seeds few or many ; placentas axile ; albumen scanty or 0.—Hard, comparatively large buds are rather characteristic of several members of the family.

Distribution

Chiefly in tropical Asia and America ; rare in temperate climates ; absent from Australia and New Zealand.

Economic and toxic aspects

The bark of ' chilauni ' (*Schima wallichii* Choisy) of the Eastern Himalayas, in which the liber cells appear like glistening-white needles, irritates the skin in the same way as cowhage. The leaves of this plant are said to contain saponins (*1*). Some members of this family have stimulant, astringent, and antidysenteric properties. The stimulants owe their action to the alkaloids caffeine and theophylline. The best known of these plants is *Camellia sinensis* (Linn.) Kuntze (*C. theifera* Griff.), which yields tea. The cultivated or ornamental camellias with rose-like but scentless flowers are derived from *Camellia japonica* Linn. which is stated by Pammel (*2*) to be a fish poison.

Constituents

The members of this family contain : (*a*) *alkaloids*, such as caffeine, theobromine, etc., (*b*) *glucosidic saponins*, such as thea saponin, schima saponin, etc., and (*c*) *essential oils* containing substances, such as $\beta\gamma$-hexenol, $\alpha\beta$-hexenal, *iso*butyl aldehyde, etc.

CAMELLIA Linn. (*Thea* Linn.)

(After George Joseph *Kamel*, or *Camelli*, a Jesuit who is said to have taken it to the West.)

Botanical characters

Trees or shrubs. Leaves evergreen, serrate. Flowers axillary, often handsome, sessile or shortly stalked. Sepals 5–6, graduating from the bracts towards the petals, which slightly cohere at the base. Stamens numerous, outer slightly or almost wholly monadelphous, adherent to the base of petals ; innermost free. Ovary 3–5-celled ; ovules 4–5 in

each cell. Capsule woody, usually short, loculicidal. Seeds mostly solitary in each cell, wingless.

From India to Japan. *Distribution*

Camellia sinensis (Linn.) Kuntze

C. theifera Griff., Fl. Brit. Ind., I, 292.

(Tea Plant)

Vernacular names: ARABIC—Chha; ASSAM—Cha, Chah, Hilkat; BURMA—Letpet; CACHAR—Dullicham; HINDI—Cha; KANARESE—Cha, Chaha, Theyale; LEPCHA—Chau; MALAYALAM—Chaya, Teyila; MARATHI—Chaha; MUNDARI—Chadaru; NEPAL—Cha; PERSIAN—Cha, Chha, Chaika, Thai; SANSKRIT—Chaha, Chavika; TAMIL—Karuppu-teyilai, Pachai-teyilai, Teyilai; TELUGU—Nalla-teyaku, Teyaku, Tiyaku; TULU—Cha; URDU—Chae, Chai; URIYA—Cha.

A shrub or small tree. Leaves elliptic, acute or acuminate, base narrowed, serrate. Flowers 1–1½ in. diam., white, solitary, peduncles *Botanical characters*

FIG. 34. *Camellia sinensis* (Linn.) Kuntze.

with a few distinct bracts, sometimes a second flower in the axil of one of them. Stamens glabrous. Ovary villous; styles 3, glabrous, connate up to or beyond the middle. Capsule depressed, 3-cornered, 3-seeded. Testa hard, shining.

Distribution

The tea plant has been cultivated from very early times in China and Japan and is now extensively grown in Assam, Bengal, Sikkim, N.-W. Himalayas, Nilgiris, etc., for the sake of its leaves.

Indian resources

Almost all the tea consumed in foreign countries is derived from India, Ceylon, the East Indies, and the Far East. With the rapid increase in the consumption of tea in England (annual consumption of tea in 1840 amounted to 1·2 lbs per head and at the close of the century it was 6·07 lbs per head) and on the Continent, an expanding market was available and the tea-growing areas in India and the East extended their resources to meet the ever-increasing demand. China remained the most important tea-producing country for a long time, but gradually India came into the field, and, through the efforts of the British tea planters, the Indian tea industry progressed by leaps and bounds. The extent to which the trade has progressed can be judged from the fact that in 1703 the import into England was somewhere about 100,000 lbs, and in the year of the battle of Trafalgar it reached 7·5 million pounds. Most of it is, at present, grown in certain areas in India, *e.g.*, Assam, Bengal, Bihar, Orissa, the United Provinces, the Punjab, Madras, Coorg, and the States of Tipperah (Bengal), Travancore, Cochin, and Mysore. A high rainfall is essential for its growth. The seeds are sown between November and March, and the seedlings are transplanted when they are at least six months old. The crop is plucked from May to December in Northern India, and from January to December in Southern India.

The total area under tea in 1937 was 834,400 acres as compared with 834,100 acres in the preceding year.

The total area under tea in 1937 distributed among the different provinces is shown below :—

	Acres
Assam	439,700
Bengal	212,700
S. India	161,600
N. India	16,400
Bihar	4,000

Most of the tea area in India lies in Assam (in the Brahmaputra and Surma valleys) and in the two contiguous districts (Darjeeling and Jalpaiguri) of North Bengal. The elevated region over the Malabar coast in Southern India (including the States of Travancore and Cochin

and the British districts of Malabar, Nilgiris, and Coimbatore) is 19 per cent of the total area under tea plantation.

Exports of tea from India compared with those of Ceylon, China, and Java are :—

	1936-37 (1,000 lbs)	1937-38 (1,000 lbs)
India	315,288	345,763
	1936 (1,000 lbs)	1937 (1,000 lbs)
Ceylon	218,149	213,133
Java	128,191	117,420
China		
(Black and Green)	55,548	59,432
(Brick, tablet, and dust)	26,650	30,176

Uses

It is the leaves of the tea plant which are used principally as a beverage and are a source of the important alkaloid caffeine. The caffeine group of compounds is found in at least six families of plants, which are scattered in different parts of the world and have acquired a double importance as medicinal drugs and articles of dietary. It is a remarkable fact how uncivilized man was guided in the selection of plants in which these compounds exist and employed them as beverages to stimulate his mental faculties and to increase his capacity for work. A strong decoction of tea leaves is used as an antidote against poisoning by alkaloids and heavy metals and as an extemporaneous means of preparing tannic-acid solution for use in the treatment of burns.

Constituents

Tea leaves contain 1 to 5 per cent of caffeine and small quantities of theophylline, hypoxanthine, adenine, and theobromine (*3*). They also contain tannins whose amount in different brands of unblended commercial tea shows variations between 9·5 and 16·8 per cent (*4*). In addition, an essential oil is present up to 0·015 per cent (*5*). The seeds contain a crystalline saponin, thea saponin, which on hydrolysis gives prosapogenin, glucose, galactose, and arabinose (*6*). They also contain an oil which is dangerous for use as food, unless refined, owing to the presence of the saponin (*7*).

Toxic effects of caffeine

The action of small doses of caffeine is mainly on that part of the brain which is connected with mental functions. It facilitates the perception of sensory stimulus as well as the association of ideas. It produces a condition of wakefulness ; drowsiness and fatigue, if present, disappear, while mental activity is increased. Larger doses of caffeine give rise to confusion of thought, associated with subjective affection of sense organs, such as flashes of light before the eyes and ringing in the ears. The individual, whose reflexes are always increased at this stage,

becomes very excitable and restless ; he is tremulous in his actions and often exhibits spasmodic movements of the limbs. This condition may terminate in tonic convulsions. Whereas in man it is principally the brain that is affected by caffeine, in animals it is the spinal cord that is chiefly attacked. The reflex irritability is increased, convulsions occur, and after large doses these are violent and tetaniform in their nature. Death is produced by asphyxia during a fit of convulsions or by subsequent central paralysis.

The circulation is affected by caffeine in a complex manner. In therapeutic doses it increases the absolute strength of the heart. Diastolic relaxation is reduced after toxic doses. In man the pulse is slowed after small doses by the central vagus stimulation and quickened after large doses by direct stimulation of the musculature or the excito-motor apparatus. The renal vessels are dilated as also the cerebral and coronary vessels.

The respiration is quickened and strengthened, owing to a stimulant action on the respiratory centre in the medulla.

The contractility of the striated muscle is increased, especially during fatigue. This is due to central action and also to direct action upon the contractile substance.

Excretion

Only a small proportion of caffeine is excreted as such, the greater part being changed into dimethyl- and monomethyl-xanthines, and finally to xanthine. Eventually, this xanthine probably breaks up into urea. The same fate is shared by theobromine and theophylline.

Toxic dosage

The fatal dose of caffeine being as large as 10·0 gm, few cases of fatal poisoning are on record. Doses of 1 gm or more may produce alarming symptoms and even therapeutic doses may produce unpleasant effects. In very severe cases there is vomiting, sometimes violent diarrhoea and tenesmus, violent choreiform tremors, collapse with small, irregular, arhythmic pulse, cold extremities and dilated pupils. There may be delirium but consciousness is not usually lost.

Acute poisoning

Acute poisoning is manifested by increased reflex irritability, increased motor activity, and impairment of mental function. With marked toxic doses there may be vomiting, convulsions, weak and irregular heart, low blood pressure, and collapse. Death takes place from heart failure, but may be due to exhaustion of the respiratory centre.

Theobromine and theophylline

Theobromine differs from caffeine in having little or no effect on the central nervous system, while its action on the muscles, heart, coronary arteries, and the kidneys is similar to that of caffeine. Its action on the kidneys is even stronger and more certain. The action of theophylline is still more pronounced, being about twice as strong on the kidneys as

that of theobromine; at the same time it possesses a stimulant action on the central nervous system and larger doses may produce convulsions both in man and animals.

Treatment

Treatment is mainly symptomatic. Elimination is promoted by free intake of water and saline per rectum.

TEA DRINKING

The following account of the use of tea in moderate and excessive doses is mostly taken from Lewin's "Phantastica" (*8*).

"We here see a repetition of the conflict between praise and condemnation in the case of tea like that found in the history of other excitants. Neither science nor experience can approve its condemnation. Besides the xanthine-complex caffeine, which is contained up to 4·5 per cent, tea contains another xanthine, theophylline (theocin), which is a dimethylxanthine. Both substances act synergetically, but the latter, according to the observation of patients who have taken it medicinally, is considerably more powerful. These circumstances were instinctively taken into consideration long before the composition of tea was known, by using far fewer tea-leaves per cup than, for instance, coffee-beans. There is no doubt that the abusive application of concentrated infusions of tea is liable to call forth physical disorders of a general nature in persons susceptible to its action, if only on account of the theophylline which, medicinally applied, is apt to give rise to symptoms of convulsions. These are said to appear if more than five cups of a concentrated infusion of tea are consumed daily. A man who from youth had become accustomed to drinking exaggerated quantities of tea and had reached a daily consumption of thirty cups suffered from symptoms of anæmia, suffocation and hallucinations. Men have been known to drink two to thirteen litres of tea daily, equalling 240 gr. of the leaves. Facts of this kind are just as unsuitable a basis for judging the good or bad properties of tea as are, for instance, the consequences of daily excessive consumption of sodium bicarbonate or artificial fruit-acid lemonades for a judgment of their properties. Even kitchen salt is toxic in certain large doses."

Excessive use

"The consequences which excessive amounts of tea are liable to produce may be ascertained in the Far East and in America where professional tea-tasters compare the value of the different kinds of tea by tasting infusions of it frequently two hundred times a day. Disorders of the gastric and intestinal functions, paleness or yellowness of the skin occur, and especially troubles of the nervous system: headache, hypochondria, weakness of memory, disturbances of the sight, and, it is

said, also atrophy of the liver. It even appears that the abuse of tea by other persons is liable to give rise to hepatic disorders. Animal experiments have proved that the consequences of tea-poisoning frequently include modification of the liver and acute nephritis."

Briefly speaking, the first symptoms produced by excessive tea drinking are epigastric uneasiness after meals, and a general lowering of the mental and physical tone. These are succeeded by restlessness and nervous excitability, tremors, and disturbed sleep, followed soon by anorexia, headache, vertigo and confusion. Palpitation, generally associated with irregularity of the heart, may sometimes become distressing, and is often accompanied by dyspnoea. In severer cases these symptoms become aggravated and continuous. Neuralgias, sensory and hysterical disturbances are also common (*9*).

" The consumption of large quantities of tea-leaves, which was once observed, also belongs to this group of aberrations. Half a pound of tea was consumed, giving rise to serious delirium. "

Tea cigarettes

" A disagreeable state of excitation is also caused by the abuse which was and may still be customary in England of smoking cigarettes said to contain Haysan-tea. This abuse is principally practised by women, and one of these, a well-known novel-writer, smoked twenty to thirty such cigarettes daily during her work. Under these conditions one-quarter to three-quarters of the caffeine originally contained in the tea, which is approximately 2 per cent, passes into the smoke, and is apt to reach the lungs. The consequences are trembling, general restlessness, palpitation of the heart, etc."

Moderate use

Leaving aside these abusive applications of tea, there is hardly anything to be said against the habitual drinking of tea in moderation, even less than against coffee. Tea usually does no harm if the consumption is kept within bounds but nervous individuals, who are the most apt to be injured by caffeine, are most likely to exceed these bounds. The bad effects are usually not very serious and disappear promptly if the habit is discontinued. Some of the symptoms, such as palpitation, anxiety, tremors, restlessness and nervousness, arise partly from the aromatic substances contained and principally from caffeine of which an ordinary cup of tea contains $1\frac{1}{2}$–3 grains ; anorexia, dyspepsia, cardialgic pain and constipation must be ascribed to the tannic acid. It is well known that moderate quantities of tea are not only not harmful but are refreshing and the mild stimulation produced by it is beneficial to mankind.

" Excluding exaggerated doses and hypersensitive individuals it is true .... that tea not only, like coffee, stimulates the digestion of

amylaceous substances, and reinforces the absorption of gastric peptones and the casein of milk and cream, but also agreeably excites the central nervous system, which maintains or even slightly raises the normal degree of cerebral activity without resulting in a subjective impression of compulsion, i.e. an activity which cannot be mastered by the individual. These favourable effects are called forth even in cases where under normal circumstances fatigue would have diminished the active capacity. Besides giving rise to a certain kind of euphory, tea promotes the faculty of judgment and facilitates intellectual work, the maximum being reached after about forty minutes. Approximately 10 gr. of Pekoe tea increase the output of mental and muscular work by 10 per cent."

Our own experience with tea is in accord with that of Louis Lewin.

Tea in animals

" Animals also respond to tea by a state of excitation. On his expedition in Tibet, McGovern saw an ostler give a large vessel of strong tea to the weary horses. This method is in general use in such cases in Sikkim. The horses eagerly drink the tea and become nimble and active. A mule became so excited that it tried to run away and gambolled about like a young colt. The use of tea does not give rise to an imperative craving for its application or for an increase of the dose, as is the case with narcotics. Nevertheless such cases have been recorded in persons who exhibited other aberrations of cerebral life with respect to morbid desires."

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Family XVI.—MALVACEAE

(Mallow Family)

Botanical characters

Herbs, shrubs, or rarely soft-wooded trees, with tenacious inner bark and usually mucilaginous juice, more or less covered with stellate hairs. Leaves alternate, commonly palminerved, simple, lobed or rarely digitate, stipulate. Flowers often showy, mostly with an epicalyx (bracteoles). Sepals usually 5, valvate, more or less connate below. Petals 5, twisted and imbricate, often connate below. Stamens indefinite (rarely definite), more or less monadelphous into a tube, which is often adnate to the base of the corolla and branches into free filaments above, rarely 5-adelphous, or some filaments quite free; anthers ultimately 1-celled. Ovary 2-many-celled, entire or lobed, of 2-many carpels; styles connate below or throughout their length; ovules 1 or more in each cell on the axis. Fruit of dry indehiscent or dehiscent cocci separating from the central axis, or capsular and loculicidal, rarely large woody and indehiscent. Seeds reniform or obovoid; albumen scanty, often mucilaginous or 0.

Distribution

A large family of warm and temperate regions; well represented in India.

Economic and toxic aspects

This family contains a number of plants of great economic importance. The inner bark of some, such as species of *Hibiscus*, *Sida*, *Abutilon*, etc., can be worked into a valuable fibre. Several species are garden favourites. The cotton plant (*Gossypium* sp.) is the most important member of the family, the hairs (floss) covering the seeds forming the cotton-fibre. The seeds are a valuable food for cattle, but have occasionally produced toxic effects. The bark of cotton-root has been used in indigenous medicine as a substitute for ergot to check all forms of uterine haemorrhage. The young fruits of lady's-finger (*Hibiscus esculentus* Linn.) are greatly relished as a vegetable in India, and *H. rosa-sinensis* Linn. and *H. schizopetalus* (Mast.) Hook. *f.* are the well-known ornamental shrubs. The 'kapok' or floss on the seeds of *Ceiba pentandra* (Linn.) Gaertn. (*Eriodendron anfractuosum* DC.) is a fibre of great merit, and is commonly used in upholstery. The capsules of 'simul' or red silk-cotton tree (*Bombax malabaricum* DC.) yield the cotton largely used for stuffing pillows and quilts. Marsh mallow (*Althaea officinalis* Linn.) is used in medicine as a demulcent. Hollyhock [*A. rosea* (Linn.) Cav.] and the baobab (*Adansonia digitata* Linn.) are cultivated in gardens for ornamental purposes. Portia or umbrella

tree [*Thespesia populnea* (Linn.) Soland. *ex* Corr.] is cultivated as a road-side tree, especially in the tropical regions. Musk-mallow (*Hibiscus abelmoschus* Linn.) seeds yield about 0·2 to 0·5 per cent of an essential oil having an odour resembling a mixture of musk and amber. This oil is used in perfumery, and also as an adulterant of pure musk.

Most of the plants belonging to this family contain free mucilage, and, generally speaking, have emollient, laxative, antibilious, and antiscorbutic properties. Some members yield volatile oils which are stimulant, diaphoretic, and diuretic. The seeds are often oleaginous. Very few species have toxic properties.

Constituents

Members of this family have been found to contain: (*a*) *alkaloids*, such as ephedrine and others, (*b*) *glucosides*, such as gossypitrin, quercimeritrin, etc., and (*c*) *phenolic compounds*, such as gossypol.

KEY TO THE GENERA

A. Fruit capsular. Stigmas coherent in a club-shaped mass. Bractooles 3, large, cordate .. .. .. 1. *Gossypium*.

B. Ripe carpels separating from the axis. Styles as many as the carpels.

a. Bracteoles 3, free. Stigmas linear. Ovules solitary, ascending .. .. .. 2. *Malva*.

b. Bracteoles 0. Stigmas terminal. Ovules solitary, pendulous .. .. 3. *Sida*.

1. GOSSYPIUM Linn.

(From the Latin *gossypion*, *gossipion*, said to be from the Aryan *goz*—a soft substance.)

(Cotton Plants)

The common vernacular generic name for all cottons is 'rui' and 'kapas' for the floss.

Botanical characters

Tall herbs, shrubs or low trees. Leaves usually 3–9-palmately-lobed. Flowers large, yellow or purple. Bracteoles 3, large, cordate, sprinkled like the calyx as well sometimes as the leaves and other parts with black glandular dots. Calyx truncate or shortly 5-toothed. Staminal tube truncate or 5-toothed at the summit. Ovary 5-celled; style clavate, 5-grooved at the apex with 5 stigmas. Capsule loculicidally 3–5-valved. Seeds densely clothed with cottony hairs.

Distribution

Numerous forms of this genus embracing the cotton-yielding plants are distributed by cultivation throughout the hotter regions of the globe. For details the reader is referred to the exhaustive accounts in Watt's "Dictionary of the Economic Products of India" and the recent monograph on Indian cottons by Hutchinson and Ghose (*1*) of the Institute of Plant Industry, Indore.

Economic and toxic aspects

The following account holds good for *G. herbaceum* Linn. and probably for several other forms as well.

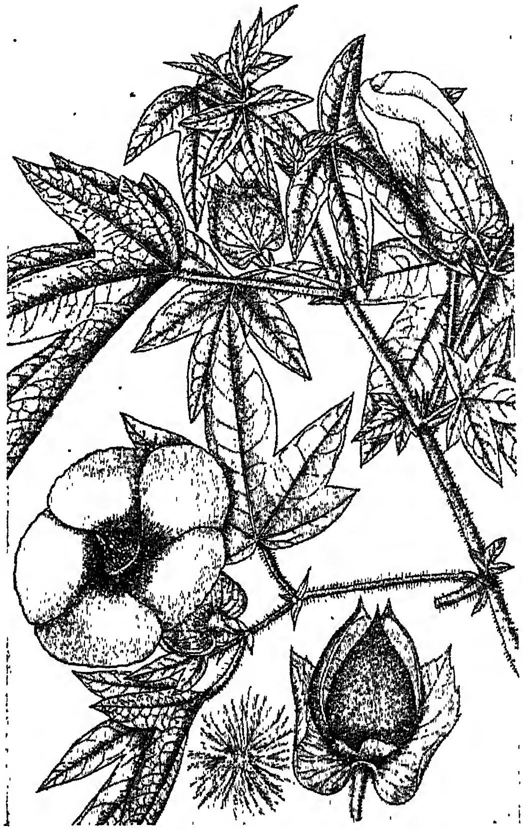

FIG. 35. *Gossypium herbaceum* Linn.

The seeds are a valuable feed for livestock and several parts of the plant, especially the root-bark and seeds, are used in medicine. Attention appears to have been first drawn to the emmenagogue property of the root-bark from the observation of Dr. Bouchelle of Mississipi who stated that it was used by Negro women to procure abortion. According to Watt (2), there appears to be little doubt that it acts like ergot upon the uterus.

Constituents

Cotton-root bark contains a pale-yellow or colourless acid resin which is present to the extent of about 8 per cent. From an alcoholic extract of the bark, dihydroxybenzoic acid, salicylic acid and two substances of a phenolic nature have been separated together with betaine, a fatty

alcohol, phytosterol, ceryl alcohol and a mixture of fatty acids (*3*). The bark is said (*4*) to possess slight narcotic properties, while the resin (*5*) obtained from it has emmenagogue properties. Fresh flowering plants yield about 0·003 per cent of an essential oil (*6*). Cotton-seed meal contains from 0·0059 to 0·053 per cent of a phenolic compound named gossypol (*7*).

Poisoning

Feeding with cotton-seed meal sometimes produces toxic effects; this is due to the presence of gossypol. This is a crystalline substance, the solution of which acts as a capillary poison resulting in local inflammation and oedema. The symptoms of slow poisoning by feeding experimental animals (dogs, rabbits, cats) with cotton-seed meal consist of diarrhoea, loss of appetite, emaciation, oedema of the lungs and shortness of breath, neuritis, and paralysis. The disturbances of digestion and nutrition are due to enteritis which is severe and may be haemorrhagic. Injections of alkaline or oily solution of gossypol produce marked irritation and oedema at the site of injection. Intravenous and intraperitoneal injections produce pulmonary oedema. The root-bark of cotton, which also contains gossypol, has been used as an abortifacient but does not seem to be very effective (*8*).

Recent investigations show that cotton-seed meal poisoning in pigs is probably not due to a toxic substance in the cotton-seed meal, but is brought about to a greater or lesser degree from iron deficiency in an ill-balanced diet. Iron in the shape of ferric oxide appears to have a specially beneficial effect in preventing the onset of symptoms (*9*).

Anthelmintic effect

The ozonide of cotton-seed oil is found just as effective against *Ascaris lumbricoides*, *in vitro*, as the oil of chenopodium (*10*).

2. MALVA (Tourn.) Linn.

(The classical name of some members of the family, probably from the Greek *malache*, from *malakos*—soft; alluding either to its demulcent properties or to the soft downy leaves.)

Botanical characters

Downy herbs. Leaves angled or lobed. Flowers axillary, clustered, sometimes solitary. Bracteoles 3, free. Petals notched. Ovary many-celled; styles as many as the carpels; stigmas linear; ovules 1 in each cell, ascending Cocci forming a round depressed fruit, indehiscent, not beaked.

Distribution

In temperate Europe and Asia, North Africa; many are cultivated.

Malva parviflora Linn.

Fl. Brit. Ind., I, 321.

Vernacular names: PUNJAB—Gogisag, Nanna, Narr, Panirak, Sonchal, Supra.

Botanical characters

A small spreading herb, slightly downy. Leaves roundish, cordate, 1–2½ in. diam., obsoletely 5–7-lobed, crenulate. Peduncles short,

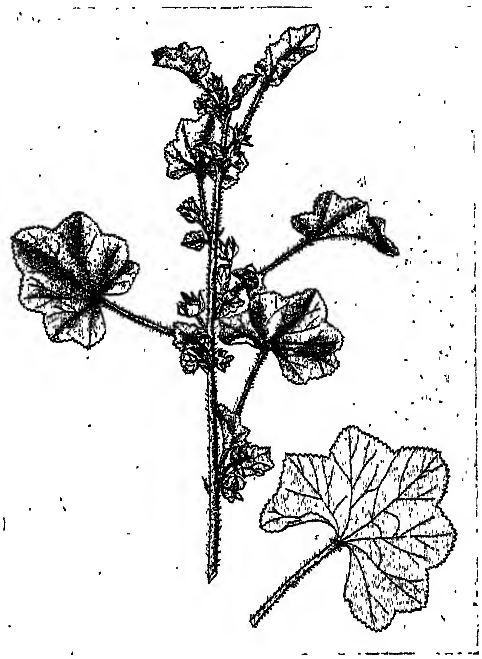

FIG. 36. *Malva parviflora* Linn.

spreading after flowering. Bracteoles linear. Sepals accrescent. Petals hardly exceeding the sepals, pale-pink; claw glabrous. Carpels wrinkled.

Distribution

Found in the North-Western Himalayas up to an altitude of 5,000 ft., also in the Punjab plains, Sind, Baluchistan, Bombay, the United Provinces, Upper Bengal, the Deccan, Mysore, and Madura.

Uses

The seeds of this plant are used as demulcent in cough and ulceration of the bladder. In Kunawar the root is stated to be used by women to cleanse their hair; woollen clothes are also washed with it. It has been observed that the plant is eaten as a potherb in times of scarcity,

Toxicity

but Burtt-Davy (*11*) regards it as dangerous for the livestock though it is regarded as a plant of good nutritional value. Animals develop spasms if they are worked or driven soon after feeding on this plant. The following symptoms are observed: Stiff gait with back

arched and head extended, repeated falling and struggling to rise until exhausted, trembling or shivering, particularly of the shoulders and hind quarters; temperature from 104° to 106°F (*12*). In Australia it is reported to produce the disease known as "staggers and shivers" in livestock; this has been reproduced by feeding tests (*13*).

3. SIDA Linn.

(A name given by Theophrastus to an aquatic plant supposed to be identical with *Althaea*.)

Botanical characters

Herbs or undershrubs. Leaves simple or lobed. Flowers rarely over ¾ in. diam., yellow or white. Bracteoles 0. Sepals connate into a broad tube below. Staminal tube dividing above into numerous antheriferous filaments. Ovary of 5–12 cells with 1 pendulous ovule in each; styles as many as carpels; stigmas terminal. Ripe carpels separating from each other and from the axis, generally 2-awned at the summit or convergent at the points, and dehiscing irregularly or by a small chink.

Distribution

Throughout the warmer parts of the world; most abundant in America.

Economic aspects

The roots of several species are prescribed in indigenous medicine in nervous and urinary diseases and in fever.

S. cordifolia Linn., found in moist places throughout tropical and subtropical India, contains about 0·08 per cent of alkaloids, the seeds being richer in the alkaloidal content. Ephedrine has been identified as one of the constituents of the alkaloidal portion (*14*).

The active principle of *S. cordifolia* has a well-marked sympathomimetic action. A detailed study of the pharmacological action of the alkaloid on various tissues and organs shows that it closely resembles that of ephedrine (*15*).

Sida rhombifolia Linn.

Fl. Brit. Ind., I, 323.

Vernacular names: ASSAM—Boriala; BENGAL—Pitabala, Pithala, Swet-berela; HINDI—Bariara, Bhiunli, Kharenti, Pitabala, Sahadebi, Sahadeva, Swet-berela; GUJERATI—Baladana; KANARESE—Bennegaragu, Gubethade-gida, Kallan-gadale; KHASI—Soh-byrthit-rit; MALAYALAM—Ana-kuruntotti, Totti, Valan-kuruntotti, Vatturam; MARATHI—Chikna, Sadeda, Sahadevi; PORBANDAR—Betraubal, Betraubaldana; SANSKRIT—Atibala, Mahabala, Pita-pushpa; TAMIL—Athiballa-chedi, Sitamutti; TELUGU—Gubatada, Muttavapula-gamu; TULU—Kadiru; URIYA—Dhola-badianla, Nalo-badianla.

Botanical characters

A small erect undershrub. Branches rough with stellate hairs. Leaves 1–2 in., rhomboid-lanceolate or obovate, acute, more or less

stellately hairy beneath, entire towards the base, dentate-serrate above; stipules linear-setaceous, longer than the petiole. Peduncles axillary

FIG. 37. *Sida rhombifolia* Linn.

or clustered at the ends of the branches. Flowers $\frac{1}{4}$–$\frac{1}{2}$ in. diam., yellow or white. Sepals deltoid, acute or acuminate. Carpels 10, with short or long beaks.—Very variable in the form of leaf, relative length of the peduncle, position of joint, and size of the carpellary beaks. In the Fl. Brit. Ind., 5 more or less distinct varieties are described.

Distribution Widely distributed throughout the tropical regions of India.

Uses In common with other *Sida* species, this plant is largely used in indigenous medicine, and yields a good fibre. The stems abound in mucilage and are employed as demulcents and emollients both for external and internal use. In Europe and other parts of the world, the plant has been regarded as a valuable remedy against tuberculosis and rheumatism. It is also used as a remedy against snake bite.

According to Pammel (*16*), the ripe capsules (carpels) cause death in fowls which feed on them. Steyn (*17*) records that the plant has been suspected of causing "dronkgalsiekte" in cattle in South Africa, but a feeding test on a sheep gave negative results. *Toxicity*

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Family XVII.—LINACEAE

(Flax or Linseed Family)

Botanical characters

Herbs or shrubs, rarely trees. Leaves alternate, simple, usually entire; stipules lateral, intrapetiolar or 0. Flowers 2-sexual. Sepals 5 (rarely 4 or 6). Petals 5 (rarely 4 or 6), usually fugacious, often clawed, ligulate in *Erythroxylum*, contorted or (in Erythroxyleae) imbricate. Stamens as many as the petals with as many interposed staminodes, or twice (as in *Erythroxylum*), rarely thrice, united at the base. Glands 5, usually adnate to the staminal ring, or 0. Ovary entire, 3–5-celled; ovules 1–2 in each cell. Fruit capsular, septicidally splitting into as many or twice as many valves as there are cells to the ovary and leaving no axis, less commonly a drupe.

Distribution

In temperate and tropical regions.

Economic and toxic aspects

The flax or linseed plant and the coca plant are two very important members of this family. The flax or linseed plant (*Linum usitatissimum* Linn.) is widely cultivated in Europe for its fibre and seed, the latter being used as food for poultry. It is cultivated in India chiefly for its oil-yielding seeds. The residual cake obtained after expressing the oil is used as food for cattle. Cases of poisoning of livestock due to this plant have been reported in different parts of the world and are due to the presence of a cyanogenetic compound. The blue-flowered *L. perenne* Linn. grows wild and is sometimes cultivated for ornamental purposes. The coca or cocaine plant (*Erythroxylum coca* Lam.), a native of South America, was once experimentally cultivated in India. The alkaloid cocaine obtained from this plant is largely used in medicine as a drug for producing local anaesthesia; for its euphoric effects it is also used in many countries as a drug of addiction.

The seeds of some of the plants of this family are oleaginous, mucilaginous, emollient, and occasionally purgative.

Constituents

The members of this family have been found to contain: (*a*) *alkaloids*, such as cinnamyl cocaine, cocaine, ecgonines, hygrines, pseudo-tropeines, and truxillines, (*b*) *cyanogenetic glucosides*, such as phaseolunatin (linamarin), (*c*) *bitter substances*, such as linin; (*d*) *saponin-like substances*, and (*e*) *essential oils*.

KEY TO THE GENERA

a. Shrubs or small trees. Petals with a double ligule. Stamens 10–12. Drupe 1-celled, 1-seeded .. .. 1. *Erythroxylum*.

b. Herbs. Stamens 5. Styles 5. Capsule septicidal .. 2. *Linum*.

1. ERYTHROXYLUM P. Br. (*Erythroxylon* Linn.)

(From the Greek *erythros*—red, and *xylon*—wood; so named from the bright-red wood of some species occasionally used for dyeing.)

Botanical characters

Shrubs or small trees. Leaves entire, often subdistichous; stipules intrapetiolar, often imbricating on the short arrested leafless shoots. Flowers axillary, small, whitish, solitary or fascicled. Sepals 5, rarely 6. Petals 5–6, clawed, with an erect double ligule on the inner base. Stamens 10–12, monadelphous. Ovary 3–4-celled; styles 3–4, free or more or less united, apices free with capitate or clavate stigmas. Drupe 1-celled, 1-seeded.

Distribution

Almost entirely confined to the tropical regions, chiefly of America.

Economic and toxic aspects

E. coca Lam., the commercial source of the well-known drug cocaine, is dealt with in detail hereafter. *E. monogynum* Roxb. (bastard sandal or red cedar) is a shrub or a small tree of the dry hill forests of Western and Southern India. Its wood is used in indigenous medicine and also as an adulterant of the true sandalwood. The leaves of this plant are considered to be refrigerant and are occasionally used as food and fodder; they are stated to have been largely used in the Madras famine of 1877 by the starving poor (*1*). They were found to contain a small quantity of alkaloids, chiefly cinnamylcocaine, an essential oil, and a crystallizable flavone compound. The alkaloid did not produce anaesthesia or mydriasis in cats (*2*).

Erythroxylum coca Lam.

(Coca Bush, Cocaine Plant)

Botanical characters

A shrub 2–5 ft. high, or a small tree 12–18 ft. high, kept down under cultivation to 5 ft., much branched; bark reddish-brown with persistent leaf-scars. Leaves chiefly confined to the upper branches, 1½–2 in. long, membranous, oval, acute at both ends; midrib slender with 2 subsidiary nerves running in a curved line from base to apex on either side, more conspicuous below, the space between the two parallel nerves being more sunk than the rest and differing in colour. Flowers small, white, in fascicles from axils of leafless branches. Stamens 10; filaments united below into a short tube. Drupe oblong, red.

Distribution

It is a native of Peru in South America and is extensively cultivated throughout the Andes Mountains at altitudes of 2,000 to 9,000 ft. above the sea level. It is also cultivated in Java and in the West and East Indies. The above description is that of the typical Peruvian plant but variations depending on soil, climate and under special conditions of cultivation occur, when the leaves are pale green in colour, obovate in shape, and the plant is diffusely branched and leafy in habit. This

is the mother plant from which hundreds of plants now in cultivation in India and other parts of the world were distributed from Kew, where

FIG. 38. *Erythroxylum coca* Lam.

the plant was raised from seed about the year 1870 (*3*). The plant was experimentally cultivated in Madras, Mysore, Bengal, and the Ranchi plateau, but proved a failure from the commercial point of view. It is now occasionally found as an ornamental plant in some gardens in India.

Production of euphoria

The use of coca leaf for euphoric purposes started in South America many centuries ago. The natives of Peru and Bolivia were in the habit of chewing the leaves when undergoing great physical strain, such as long laborious marches in the hills. The leaf was usually taken mixed with lime or ashes of some plant, and chewing this mixture refreshed and invigorated the users. The powdered leaves were kept in flask-shaped gourd shells and small quantities were removed from it with a needle the end of which was moistened with saliva. A number of other preparations made from the leaf were also used by these people. The planters and miners encouraged its use among their labourers as they could get more work out of them while under its influence. Though the alkaloid cocaine was discovered in 1859–60 its importance from the medicinal point of view was not appreciated until 1884.

Constituents

The alkaloids obtained from the coca leaves fall into the following four groups: (*a*) *cocaines*, *e.g.*, cocaine, cinnamylcocaine, α-truxilline and β-truxilline, (*b*) *pseudotropeines*, *e.g.*, tropacocaine, (*c*) *acylecgonines*, *e.g.*, benzoylecgonine, (*d*) *dihydroxytropane*, and (*e*) *hygrines*, *e.g.*, hygrine, β-hygrine, cuscohygrine. The nature of the alkaloids of coca leaves varies with age, the youngest leaves being richest in cinnamylcocaine whilst the older leaves contain more cocaine (*4*). The Java leaves are said to contain 0·6 to 2·4 per cent of alkaloids of which cinnamylcocaine is the chief constituent (*5*). The Ceylon leaves are said to contain 0·7 to 1·6 per cent of the total alkaloids of which cocaine forms the chief constituent (*6*). Coca leaves grown experimentally in India and examined by Howard contained 0·4 to 0·8 per cent of alkaloids, largely cocaine (*7*), but some specimens examined by us contained only traces of the alkaloids. The seeds are also said to contain cocaine (*8*). The Java leaves contain 0·06 to 0·13 per cent of an essential oil (*9*).

The dried leaves of *E. coca* (Bolivian or Huanuco leaf) are preferred for medicinal purposes since a larger proportion of their alkaloidal content consists of cocaine. Java supplies most of the Truxillo variety. Ceylon was at one time a regular producer, but its cultivation was abandoned at the request of the British Government. Coca is now frequently evaluated on its ecgonine content since commercial cocaine is obtained synthetically from ecgonine.

COCAINE

Cocaine, the characteristic alkaloid of coca leaves, is of great medicinal value as a local anaesthetic. Tropacocaine is the only other coca alkaloid which has found direct use in medicine. It resembles cocaine generally in action but produces local anaesthesia more rapidly, is less poisonous, and causes little or no mydriasis (*7*). The alkaloids of the hygrine group have no physiological action.

Peripheral action

Cocaine produces on the tongue a sudden and characteristic cessation of feeling which lasts only for a few minutes. One drop of a 4 per cent solution (of the hydrochloride) placed on the tongue soon produces a decided numbness, the effect disappearing quickly unless the application be repeated. Cocaine also produces an intense local anaesthesia and blanching effect on the mucous membrane. Anaesthesia of the eye is of much value in ophthalmic operations and is produced by 10 to 20 per cent solutions. Dilation of the pupil is generally produced by cocaine whether applied locally to the eye or otherwise introduced into the system, but the mydriasis produced by it is not so invariable and is far less intense than that produced by atropine and its isomers (*10*).

Nervous system

The most important effect of cocaine is on the central nervous system and on the sensory nerves. When taken internally or otherwise absorbed into the system, coca and its alkaloids produce a sense of exhilaration and increased readiness for exertion similar to that produced by caffeine. There is a marked tendency to restlessness and wakefulness, a feeling of augmented mental and physical power, and absence of hunger. These are due to the stimulation of the central nervous system. With moderately large doses the reflexes are exaggerated ; a further increase may induce tremors and, when the dose is toxic, convulsions chiefly of clonic or epileptiform type may supervene, followed in turn by central nervous depression. Death usually occurs from paralysis of respiration.

Circulation

In moderate doses cocaine slightly stimulates the heart. The exciting action of the drug on the vasoconstrictor centre in the medulla is, however, more marked. Toxic doses of cocaine, after temporary stimulation of the circulatory function, tend to slow and weaken the heart's action.

Respiration

Full doses of cocaine stimulate the respiratory centre and the rate of breathing is greatly increased ; the depth is later diminished and the breathing sometimes becomes very shallow. After poisonous doses the rate is secondarily slowed, especially during convulsive seizures, and death may suddenly take place from asphyxia.

Absorption

Cocaine is rapidly absorbed from the mucous membrane, but is almost incapable of penetrating the horny layer of the skin. It is mainly excreted unchanged in the urine.

Poisoning in man

Man is peculiarly sensitive to cocaine ; the cases of poisoning from it may be divided into : (*a*) those induced by rapid absorption, and (*b*) those following slower absorption of the drug. In the first type the characteristic phenomenon is syncope, and death may occur in a few minutes preceded by convulsions. In the case of the second type, *i.e.*, acute cocaine poisoning by relatively larger amounts absorbed more slowly, mental excitement, an exaggerated sense of well-being, loquacity, incoherence, and actual delirium are the typical features.

After very large doses epileptiform convulsions are likely to appear very quickly. Simultaneously or shortly after, circulatory and respiratory depression supervenes ; the pulse becomes feeble, the respiration more and more slow and irregular, and the skin cold and cyanotic. If the dose is lethal, death takes place generally through failure of the respiratory centre, abetted by cardiac and vasomotor weakness or possibly through spasm of the muscle of respiration during a convulsive seizure.

Poisoning in animals

In the dog, cat and rabbit, the symptoms are invariably those of stimulation of the central nervous system. The animal shows symptoms of restlessness and excitement; later convulsions occur, which are at first clonic but may afterwards become tonic. Even before convulsions appear the animal becomes partially unconscious and, in the intervals between the seizures, lies in an apathetic state which soon deepens into coma or death from asphyxia.

Examples of cocaine poisoning are rare in animals, not at all likely in horse or ox, and not often in dog. The toxic doses in grains per pound body weight are approximately: horse $\frac{1}{24}$ grain, ox $\frac{1}{30}$ grain, and dog $\frac{1}{12}$ grain, but these are probably too low (*11*).

Convulsive and fatal doses

The average convulsive dose of cocaine in man may be stated as 0·2 gm (3 grains). The ordinary fatal dose is considered to be about 1·2 gm (18 grains), but death has been reported from 0·02 gm ($\frac{1}{3}$ grain).

Treatment

No antidote is known and acute poisoning can only be treated symptomatically. Slight attacks of syncope improve on the assumption of a horizontal position and, if there is great pallor, by inhalation of amyl nitrite. Convulsions may be controlled by small whiffs of ether or chloroform; morphine is contraindicated. In cases where paralytic symptoms supervene, artificial respiration is indicated. The stomach should be washed if the drug has been taken by mouth.

COCAINE HABIT

Chronic poisoning

An irresistible craving or impulse to intoxication by cocaine or any of its salts or combinations is met with in many parts of the world. One of the frequent causes of this habit has been the improper use of the drug in therapeutics. The repeated use of the alkaloid to incite pleasurable intoxication has been responsible for addiction. Chronic poisoning (cocainophagia or cocainomania) occurs among those who have been accustomed to its use either by internal administration by mouth or by subcutaneous injection. The symptoms of this poisoning are: insomnia, digestive derangements, wasting, emaciation, rapid pulse, impotence, defective memory, physical and moral degeneration, derangement of the special senses, visual and other halucinations, melancholia and mania with delusions of persecutions. The characteristic symptom known as Magnan's symptom, complained of by the patient, is a feeling as if grains of sand were lying under the skin or some small insects (cocaine bugs) were creeping on the skin giving rise to an itching sensation. Hartman reports that homosexuality is often seen among cocaine addicts and cites several cases of men and women

who got into this habit after they took to cocaine, but the perversion disappeared after the drug was stopped.

Toxic effects

The prognosis of cocainomania is not very favourable. Cocaine exhausts the mental capacity more rapidly than any other drug of addiction. It takes a greater hold on the brain and nervous system, reducing the addict's intelligence and benumbing his faculties, setting up a moral palsy which seems to deprive the victim of all desire for deliverance. These cases are best treated in an institution.

Post mortem, there is marked hyperaemia of the brain, spinal cord and other internal organs.

Chronic Poisoning with Cocaine in India (*12*)

Cocaine habit in India

In Western countries cocaine is generally taken by subcutaneous injection or in the form of snuff. In India the usual mode of indulgence is by mouth with betel leaf. The symptoms produced in all forms of indulgence are similar, there being only a question of degree. The following symptoms and effects produced in cocaine addicts in India have been recorded :—

Immediately after taking the drug there is a slight smarting or tingling sensation in the tongue; the lips feel swollen, dry, and thick. There is irritation in the fauces and sensation of constriction in the throat, followed soon after by a complete loss of sensation in the oral cavity, tongue, and lips. There is a feeling that the tongue is missing from the mouth. After these preliminary sensations, which last only for a few minutes, the drug begins to enter into the circulation, and this is the beginning of the stimulant stage. There is a slight feeling of dizziness or heaviness in the head, a throbbing sensation in the arteries of the neck, and palpitation of the heart. The unpleasant sensations of confinement and air hunger, sometimes occurring after subcutaneous injection, is not frequently met with when the drug is taken by mouth, unless the saliva be swallowed or enters the stomach by trickling through the oesophagus. The pulse becomes slightly full and quick, but, as a rule, does not exceed 100 to 110 per minute. There is a very pleasant feeling of warmth all over the body. By this time a peculiar sensation of excitement is felt by the individual; he feels cheerful and has a sensation of comfort both of the mind and the body. He feels capable of undertaking any physical or mental strain. During this period the patient looks very keen and excited, his eyes are bright and he talks coherently. Complicated intellectual work may be done during this period without mistakes. The increased sensitiveness of the sensory nerves makes proper conception of nerve

impressions impossible, and the addict gets agreeable hallucinations. The stage of excitement after taking cocaine lasts from 45 minutes to an hour or an hour and a half. During this stage the addicts like the company of other addicts and mutually persuade one another to indulge more and more in the drug, leading to long continued cocaine debauches. Advanced hours of night do not induce them to retire to sleep, as during cocaine intoxication sensation of sleep is entirely absent. In this respect cocaine differs from other euphoric drugs, such as opium, hemp drugs or alcohol, which sooner or later produce drowsiness and sleep. While the individual is under the influence of cocaine there is complete loss of appetite, but often a very intense feeling of thirst appears. Constipation is a common symptom, being the most distressing feature occurring in cocaine addicts ; it was stated that the bowels were heavy and there was a very unpleasant sensation of fullness in the abdomen ; the feeling was described as if the inside were full of stones. This was readily relieved by a dose of the alkaloid, the effect being so strong that a rush had to be made for the latrine.

Toxic effects

In case of stronger intoxication, either by bigger doses or by abnormal sensitiveness of the individual, hallucinatory symptoms of fear or persecution quickly appear. Sometimes, especially after larger doses have been taken, there is a feeling of sickness, nausea, vomiting, and cramps in the muscles. If toxic doses of cocaine were taken, the addict becomes semi-conscious, gets twitching of the muscles of the face and general tremors of the body followed by convulsions. The body temperature shows a considerable tendency to rise. Convulsions can easily be controlled by sedatives, and, if severe, inhalations of chloroform must be given. Very often these convulsions pass off, the patient gaining consciousness, but feeling utterly exhausted and miserable. A dose of cocaine revives the victim. Paralytic symptoms appear if very large doses were taken, and are followed by coma and death from stoppage of respiration. The toxic symptoms appear only after toxic doses or as a result of prolonged indulgence.

Abstinence symptoms

The foremost of the abstinence symptoms is a strong craving by the addict to repeat the dose. After the effect of one dose is over, the desire for the next dose is almost irresistible. There is such a strong desire for the drug in some individuals that they will commit any kind of crime, for example, a woman would even sell her honour to get the drug. The victim feels restless, irritable, quarrelsome, and unable to concentrate. There is a great disinclination for mental and physical exertion ; the addict feels dull, drowsy, and lazy, exhibiting a state of complete lethargy and inertia. Abstinence symptoms entirely disappear for the time being, if a dose were taken.

Cocaine addicts

The general appearance of cocaine addicts is very pitiable. When one has seen a few, they are not difficult to recognize. As a rule, they are emaciated, sickly and flabby-looking individuals with a dull facial expression. They have no regard for their personal appearance, cleanliness of their body or of clothes. They are pale and anaemic, with a sallow complexion, sunken eyes, dilated pupils, prominent cheeks, and present an appearance as if suffering from severe toxaemia. In the vast majority of addicts, there is a blackish-red deposit on the teeth. This is said to be very distinctive with cocaine eaters in India and, by some, is regarded as a diagnostic sign. The usual colour of 'pan' or betel leaf in the mouth is red, on account of the catechu contained in it; the colour of the teeth and tongue of cocaine eaters, however, is dark brown or chocolate.

The discoloration of the tongue and the teeth does not disappear for even a month after the drug has been given up. The black deposit is more marked on the lower teeth, particularly on their posterior surfaces. It is more in evidence on the central incisors and canines, but not infrequently extends to the last molars. There is no doubt that this deposit is due to chemical changes taking place between lime, catechu, and the alkaloid in the alkaline medium of the saliva.

The deafness occurring among addicts is probably due to the paralyzing effects of the alkaloid on the auditory nerve endings. Superficial and deep reflexes are not affected. There is paralysis of the sensory nerve endings after local application. The skin becomes pale, there is loss of subcutaneous fat, and in some cases a peculiar rash is observed. Paraesthesia in the form of intense itching of the skin, followed by a sense of creeping of worms and insects under the skin, or of embedding of sand and pebbles under it, is frequently met with (in 30 to 40 per cent of addicts in our series).

Sexnal effects

Cocaine is popularly supposed to possess aphrodisiac properties, and quite a large number of patients start the drug for its alleged stimulating effects on the sexual faculties. During the general stimulation of the higher parts of the brain, which follows this drug, there is undoubtedly sharpening of all the senses and faculties, and this may produce a semblance of sexual stimulation. Even in this state, the alkaloid has no specific exciting effect on the sex organs, either in the male or in the female.

Treatment of cocaine habit

The treatment is general. The most important points to be remembered are: (*a*) Removal of the addict from the environments in which he learnt the habit and from the associates in whose company he indulges in the drug, preferably to a place where he cannot get the

drug. (*b*) Psychotherapy, mental training and impressing upon the addict the gravity of continuance of the cocaine habit, are very important. The patient should be encouraged to have a firm mind and to give up the drug. (*c*) The drug must be withdrawn all at once. (*d*) The remainder of the treatment is simple and symptomatic.

2. LINUM Tourn. *ex* Linn.

(The classical name of flax.)

Botanical characters

Herbs. Leaves narrow, entire; stipules 0 or glanduliform. Sepals 5. Petals 5. Stamens 5, often alternating with minute staminodes. Glands 5. Ovary 5-celled, cells imperfectly septate. Styles 5, usually free. Capsule 5-celled, septicidally splitting into 5 simple two-seeded or 10 one-seeded cocci.

Distribution

In temperate and warm regions, especially round the Mediterranean.

Linum usitatissimum Linn.

Fl. Brit. Ind., I, 410.

(Flax, Linseed)

Vernacular names: ARABIC—Bazarul-katan, Bazrut-kattan, Kattan; BIHAR—Chikna, Tisi; BENGAL—Mosina, Tisi; DECCAN—Alshi, Javas; GUJERAT—Alshi; HINDI—Alsi, Tisi; KANARESE—Alashi, Alshi; KASHGAR—Zighir: KASHMIR—Alish, Keun; KONKANI—Sonnbiam; KUMAON—Alsi, Tisi; MALAYALAM—Cheru-chana-vittinte; MARATHI—Alashi, Javasa; PERSIAN—Bazarug, Kuman, Kutan, Tukhme-katan, Zaghir, Zaghu; PORBANDAR—Alasi, Javas; PUNJAB—Alish, Alsi, Tisi; SANSKRIT—Atasi, Auma, Kshauma, Malika, Masina, Masrina, Masuna, Parvati, Pichhila, Budrapatni, San, Sunila, Suverchala, Tilottama, Uma; TAMIL—Alshi; TELUGU—Atasi, Madanaginjalu, Ullu-sulu; UNITED PROVINCES—Bijri, Alsi; URDU—Alsi; URIYA—Pesu.

Botanical characters

Annual; stems 2–4 ft., erect, usually corymbosely branched above. Leaves linear or lanceolate, without stipular glands, sub-3-nerved. Flowers in broad cymes, blue or sometimes white, 1 in. across. Sepals ovate, acuminate, 3-nerved, margins white, ciliate or not. Stigmas linear-clavate. Capsule hardly exceeding the sepals; edges of the valves ciliate. Seeds compressed, ellipsoid, dark-brown, shining.

Distribution

Extensively cultivated throughout India up to an altitude of 6,000 ft., for its oil-yielding seeds.

Uses

Linseed is largely used in medicine in the form of a poultice, which is prepared from the pulverized seeds. After extraction of the oil, which is of great commercial importance, the residual cake is fed to cattle. A pint of raw linseed oil with an ounce each of laudanum and spirits of turpentine is considered to be one of the best remedies for colic in ponies.

Poisoning

When the oil cake or oil meal is fed to hogs in concentrated form, it produces digestive troubles, frequently resulting in death (*13*). Cases

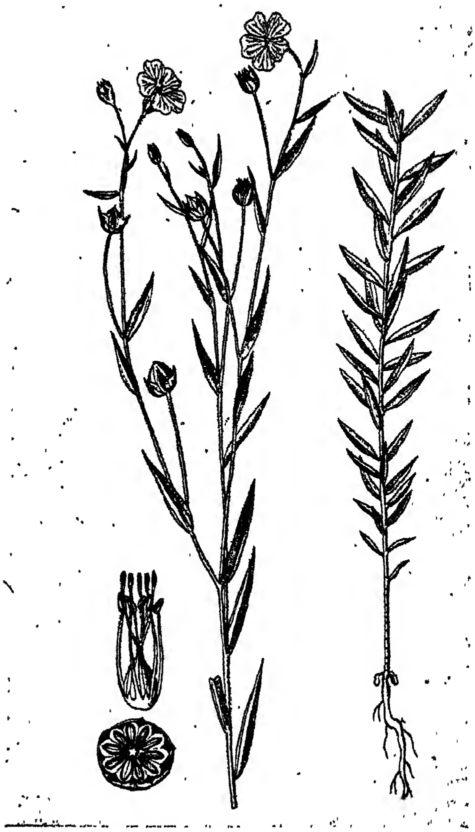

FIG. 39. *Linum usitatissimum* Linn.

of poisoning due to eating the plant by livestock are referred to in literature on the subject. It is stated to cause violent colic, distention, diarrhoea, staggering, palpitation, and death following convulsions; autopsy shows gastro-enteritis and signs of asphyxiation. Schaffner states that death in cattle is probably due to hydrocyanic acid evolved from the plant when wilting (*13*).

Hydrocyanic-acid content

The seeds contain a cyanogenetic glucoside, phaseolunatin (linamarin), which is also said to occur in other parts of the plant, such as the leaves, stems, and roots (*9*). It is said that the immature seeds contain more of the glucoside than the mature ones and that poisoning with the seeds is mainly due to the presence of immature seeds in the material

fed (*14*). As a result of experiments by Dunstan and his collaborators (*15*), it is clear that the maximum amount (1·5 per cent) of the cyanogenetic glucoside in the plant is reached at a very early stage (height of the plant—two to three inches) in the development of the plant and finally disappears except in the seed, which contains a small percentage of the glucoside. This is illustrated by the following table by Dunstan and his collaborators :—

Height of flax plant in inches	Grown at		Hydrocyanic acid found per cent	Glucoside calculated per cent
Seed	....		0·008	0·07
1–1·5	Imperial Institute	..	0·15	1·4
2–3	Ditto	..	0·17	1·5
3–4	Ditto	..	0·15	1·4
4–5	Physic Garden, Chelsea	..	0·13	1·2
5–6	Ditto	..	0·10	0·9
6–7	Ditto	..	0·10	0·9
8–10	Ditto	..	0·08	0·7
12–15	Ditto	..	0·07	0·6
15–18	Ditto	..	0·03	0·3
18	Ditto	..	0·009	0·08
18	Ditto	..	None	None

A sample of the seed (Calcutta linseed) was found to contain 0·380 mg of hydrocyanic acid per gm (0·038 per cent). The poisonous effect of the consumption of linseed on cattle would naturally depend on the rate of formation and removal of hydrocyanic acid under the usual conditions, and the chances of poisoning by dry linseed or linseed cake are, therefore, remote. Mash made from linseed meal may be dangerous when fed to calves, if the meal is allowed to collect in lumps during the preparation of the mash (*16*). Samples of linseed cake were found to furnish 0·032 to 0·045 per cent of hydrocyanic acid (*17*). Quentin considers that linseed cakes containing more than 400 mgm of hydrocyanic acid per kgm are dangerous (*18*).

Bagchi and Ganguli (*19*) report several fatal cases of accidental cattle poisoning in a village in Bihar and add that hydrocyanic acid was detected in the viscera of some cases. It was ascertained that the

animals developed symptoms of poisoning after a feed on linseed flowers. Analyses carried out by these authors of the different parts of the plant and also of the cake showed the following results :—

	Per cent of HCN
Roots	0·067
Leaves	a trace
Flowers (before fertilization)	0·08
Immature fruits	0·692
Mature fruits ready for harvesting	0·08
Linseed	0·06
Husks (used as fodder in Bengal)	0·046
Linseed cake	0·032

Bagchi and Ganguly found that, to obtain the maximum yield of hydrocyanic acid, flowers with immature seeds, which contain the largest amount of the acid, should be soaked in water for about four hours at 37°C. before distillation. The same treatment with decinormal acids and alkalies retarded hydrolysis, while a normal acid or alkali stopped the activity of the enzyme (linase) completely. The risk of hydrocyanic-acid poisoning appears to depend upon the reaction of the gastric juice, decreased acidity or a neutral reaction, effecting a complete hydrolysis of the glucoside (linamarin) and producing the maximum amount of hydrocyanic acid. About half a pound of linseed flowers is likely to kill a cow. A fairly strong solution of washing soda or any other alkali has been suggested as an antidote in cases of poisoning by linseed flowers, which is fairly common in Bengal and Bihar and possibly in other linseed-growing provinces. These authors suggest that, since cyanogenetic glucosides are found in many species of grasses (Gramineae), the possibility of poisoning by hydrocyanic acid should always be thought of in obscure cases of cattle poisoning.

Prevention of linseed poisoning

Poisoning by linseed can be prevented by (*a*) not feeding the immature plant or the seed, especially when wilted, (*b*) thorough scalding of the seed and cakes with boiling water in order to destroy the enzyme, (*c*) refraining from the dangerous custom of adding water to the cakes or seed and allowing them to stand overnight before feeding, and (*d*) feeding with small quantities at a time (*14*).

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Family XVIII.—ZYGOPHYLLACEAE

(Bean-caper or Guaiacum Family)

Botanical characters

Herbs or shrubs. rarely trees, branches usually articulate. Leaves opposite or alternate (*Peganum*), 2–3-foliolate, pinnate or multifid, not dotted ; stipules paired, persistent, sometimes spiny. Peduncles usually 1–2 in the axils of the stipules, or solitary subterminal and leaf-opposed, 1-flowered. Flowers usually regular. Sepals 5–4, usually free and imbricate. Petals 5–4, rarely 0. Disc usually present. Stamens as many as the petals, twice, or thrice (*Peganum*) as many, inserted at the base of the disc ; filaments usually with a scale inside. Ovary sessile, rarely stalked, lobed or winged, 4–5- (rarely 2–12-) celled ; style angular or furrowed. Fruit of 2–10 free or united often spiny cocci, or capsular, almost never baccate.

Distribution

Mainly xerophytes and halophytes of tropical and subtropical regions.

Economic and toxic aspects

Peganum harmala Linn. (harmel) is a common disinfectant fumigant in the Punjab. The roots of this plant are used to destroy lice. Its seeds are considered narcotic, nauseant, emetic and emmenagogue, and have been found to contain the alkaloids harmine, harmaline, harmalol, and peganine. The first two have been shown to have toxic properties. Fruits of *Tribulus terrestris* Linn. (caltrop) are used as a diuretic, and the plant has been regarded in South Africa to be the cause of "geeldikkop" (dikgeel) in small stock, which is characterized by oedema of the head, fever, and jaundice. *Guaiacum officinale* Linn., a beautiful small tree with blue flowers, is occasionally cultivated in Indian gardens. It furnishes the "lignum vitae", a hard and heavy wood used in machinery and casting work. The leaves are often acrid and used as an astringent.

Constituents

The plants of this family have been found to contain : (*a*) *alkaloids*, such as harmine, harmaline, and peganine, (*b*) *saponins*, such as guaiac saponin, etc., (*c*) *resins*, such as guaiac resin, etc., and (*d*) *essential oils* containing the alcohol guaiol, sesquiterpenes, etc.

KEY TO THE GENERA

a. An erect perennial. Leaves multifid. Stamens 12–15 .. 1. *Peganum*.

b. A prostrate herb. Leaves abruptly pinnate. Stamens 10. Fruit spinous .. .. 2. *Tribulus*.

1. PEGANUM Linn.*

(From the Greek *peganon*—rue.)

Botanical characters

. Branching perennial-rooted herbs. Leaves alternate, entire or irregularly multifid; stipules setaceous. Flowers solitary, leaf-opposed, white. Sepals often foliaceous and pinnatifid, persistent. Petals subequal. Stamens 12–15, some antherless; filaments dilated below. Ovary deeply 2–3-lobed; styles basal, twisted, 2–3-keeled above the middle, the keels stigmatose. Fruit globose, 3–4-celled, dehiscing with 3 valves or indehiscent, many-seeded. Seeds angled; albumen fleshy.

Distribution

In Central Asia, North America, and on the Mediterranean shores.

Peganum harmala Linn.

Fl. Brit. Ind., I, 486.

(Harmal, Harmel, Syrian Rue, Wild Rue)

Vernacular names: ARABIC—Harmal, Hurmul; BALUCHISTAN—Ispanthan, Spand, Spanj; BENGAL—Isband; DECCAN—Hurmaro, Vilayati-isband, Vilayati-mhendi; GUJERATI—Ispun; HINDI—Harmal, Hurmul, Isband-lahouri, Kaladana, Lahouri-hurmul; KANARESE—Sime-goranti; MARATHI—Sarmala; PERSIAN—Isband, Ispand; PUNJAB—Harmal, Isbound-lahouri, Lahouri-hurmul, Spelane; PUSHTU—Spailanai; QUETTA PISHIN—Spanda; SIBI—Harmal, Harmaro, Spanda; SIND—Hurmul, Isbund-lahouri, Lahouri-hurmul; TAMIL—Shimai-aravandi-virati, Shimai-azhavanai-virai; TELUGU—Sima-goranta, Sima-goronti; URDU—Ispand.

Botanical characters

A glabrous bush, 1–3 ft. high, dichotomously and corymbosely branched, densely foliaged. Leaves 2–3 in., multifid; segments linear, acute. Flowers $\frac{1}{2}$–$\frac{3}{4}$ in. diam., white. Calyx-lobes linear, exceeding the petals. Petals elliptic-oblong. Capsule globose, about $\frac{1}{3}$ in. diam., deeply lobed.

Distribution

Very common in the drier waste places and fields of Baluchistan, Waziristan, Kurrum Valley, Sind, Cutch, the Punjab, Kashmir, Delhi, the United Provinces, Bihar, Konkan, and the Western Deccan.

Uses and properties

The seeds yield a red dye, and various parts of the plant are used in medicine as an antiperiodic, antispasmodic, alterative, stimulant, aphrodisiac, lactagogue, and anthelmintic. The smoke of the plant is commonly used in the Punjab as a disinfectant and is believed to keep off mosquitoes. The seeds are considered narcotic, nauseant, emetic, and emmenagogue. In an elephant they are said to bring about a condition of tremendous excitement whereby the animal loses control over himself, *i.e.*, becomes 'mast'. Gopal, as quoted by Watt (*1*), found that an infusion or tincture acted as a mild emmenagogue and produced slight intoxication in the same way as hemp (*Cannabis*

*This genus is dealt with under Rutaceae in Fl. Brit. Ind.

sativa Linn.). He reported that the plant was sometimes employed by Indian midwives to produce abortion and believed that the drug has properties similar to those of ergot, savin, and rue. The powdered root mixed with mustard oil is applied to the hair to

FIG. 40. *Peganum harmala* Linn.

destroy vermin (*1*). The plant has been suspected of causing death of livestock in America, but it is rather unpalatable and not likely to be eaten by animals under normal conditions. The chances of poisoning under field conditions are, therefore, very remote.

Constituents

The seeds have been found to contain three alkaloids, harmine, harmaline, and harmalol, to the extent of 2·5 to 3 per cent. Harmaline occurs in the largest amounts, being about two thirds of the quantity of the total alkaloids, while harmalol is present in traces only. Recently another alkaloid, peganine, has been isolated from the seeds; this is stated to be identical with vasicine, the alkaloid found in *Adhatoda vasica* Nees (*2*). The seeds also contain a soft resin with a deep carmine-like colour having a heavy narcotic odour resembling that of the resin of *Cannabis sativa* Linn. (*1*).

Pharmacological action

Flury (*3*) found that harmine and harmaline had a paralyzing effect on the skeletal and cardiac muscles of frogs. In warm-blooded animals,

harmine and harmaline produce convulsions, salivation, interference with respiration, and depression of temperature (*3*). Harmaline in small doses stimulates respiration, but in large doses paralyzes it. The minimal toxic dose of harmaline for rabbits has been determined to be 0·23 gm per kgm body weight. Harmaline resembles quinine in producing more potent toxic effects in mammals than in frogs. Harmine in large doses produces tremors and clonic convulsions. With poisonous doses the convulsions are followed by motor paralysis; respiration is paralyzed and in mammals there is a fall in blood pressure, due to the weakening of the contractions of the heart; death occurs as a result of cardiac failure in these cases (*4*). Gunn and Marshall (*5*) are of opinion that harmaline belongs to the group of protoplasmic poisons of which the best-known alkaloid is quinine, and the actions of harmaline and quinamine (*6*) are practically identical. Harmaline was, however, tried in the case of patients suffering from both acute and chronic types of malaria in the Carmichael Hospital for Tropical Diseases, without any appreciable effect either on malarial parasites or on the clinical symptoms of the disease. The alkaloids are stated to have anthelmintic properties also (*7*).

The substitution of OCH_3 group in harmaline by OH in harmalol effects a considerable difference in the pharmacological properties, of which the following are the most significant. Harmaline is (in subcutaneous injections) about 2½ times as toxic as harmalol for laboratory mammals, but equally toxic for frogs. The clonic convulsions, which harmaline characteristically produces in mammals, do not occur with harmalol. Harmaline is from 30 to 60 times as toxic as harmalol for protozoa (colpidia). Otherwise the action of the two alkaloids on voluntary and involuntary muscles seems to run parallel with their general toxicity (*8*).

2. TRIBULUS Tourn. *ex* Linn.

(From the Greek *tribolos*—three-pointed, three-pronged, *treis*—three, and *belos*—a dart; referring to the fruit—*see* below.)

Botanical characters

Branching prostrate herbs. Leaves opposite, usually unequal, abruptly pinnate. Flowers solitary, pseudo-axillary, white or yellow. Petals 5, spreading, fugacious. Stamens 10 (rarely 5), 5 longer opposite to the petals, alternate shorter with a small gland outside. Ovary sessile, hirsute, 5–12-celled and -lobed; style short; stigmas 5–12. Fruit 5-angled, of 5–12-winged or spinous or tuberculate indehiscent cocci. Seeds exalbuminous.

Distribution

In tropical and warm regions.

Tribulus terrestris Linn.

Fl. Brit. Ind., I, 423.

(Calthrop, Caltrap, Caltrop)

Vernacular names: AFGHANISTAN—Krunda; ARABIC—Bastitaj, Buste-rumi, Khasak; BENGAL—Gokhru, Gokhuru, Gokshura; BORI—Skarvandi; BURMA—Charatte, Sule-anen; CENTRAL PROVINCES—Gokhru; DECCAN—Ghokru, Kante-ghokru; GUJERAT—Beta-gokhru, Gokharu, Gokhru, Mitha-gokhru, Nhana-gokhru; HINDI—Chhota-gokhru, Gokhru, Gokhuru, Gokshri, Goksura, Hatechanghara, Hussuk; KANARESE—Negalu-mullu; LADAKH—Kokullak, Rasha; MALAYALAM—Neringil, Nerinnil; MARATHI—Ghokaru, Lahana-gokharu, Charatte, Sarata; NASIRABAD—Bhakhra; PERSIAN—Khare-khasak, Khasak; PUNJAB—Bakhra, Bhakhra, Bhukri, Gokhru-desi, Lotak; PUSHTU—Kandalai, Malkundai; SANSKRIT—Gokhurha, Gokshura, Gokshure, Ikshugandha, Sthalasringataka, Sudumstra, Trikantaka, Vanasrangata; SIND—Gokhru, Trikundri; TAMIL—Nerrenji-kiray, Nerunji, Nerunji-mullu, Siru-nerinji; TELEGU—Chiri-palleru, Chiru-palleru, Palleru, Palleru-mullu; URDU—Gokharu; URIYA—Gokhura, Gokshra.

Botanical characters

Densely hairy, with prostrate branches 1–2 ft. long. Leaves 2–3 in. long, often unequal in a pair; leaflets 4–7 pairs, oblong with

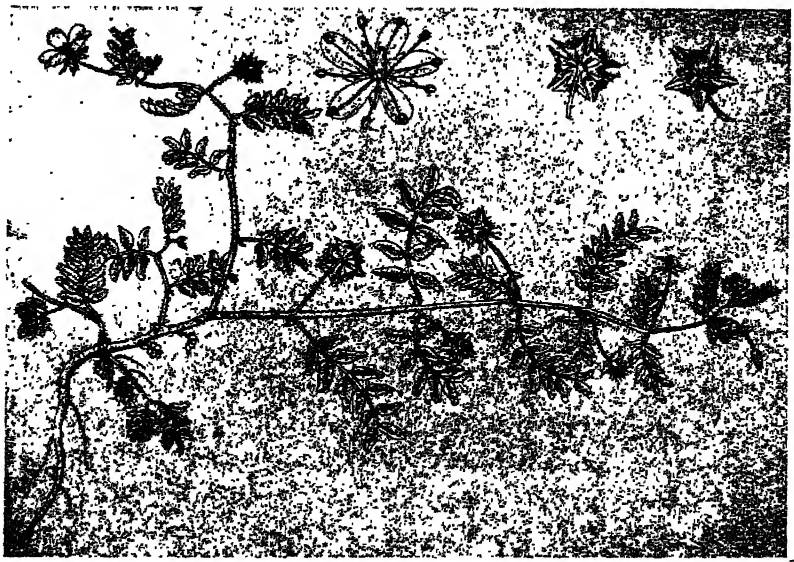

FIG. 41. *Tribulus terrestris* Linn.

oblique base, mucronate, $\frac{1}{3}$–$\frac{4}{5}$ in. Flowers pale-yellowish, $\frac{1}{3}$–$\frac{3}{5}$ in. diam., on peduncles $\frac{2}{5}$–$\frac{1}{2}$ in. Fruit usually hairy, cocci each with 2 very sharp rigid spines and 2 shorter ones.

Distribution

Grows commonly throughout India, ascending to an altitude of 11,000 ft. in Western Tibet.

Uses

The entire plant and particularly the fruit is extensively used in indigenous medicine. The fruit is one of the ten ingredients of the 'dasamula kvatha', a compound decoction frequently mentioned in Sanskrit literature. Water rendered mucilaginous by the plant is drunk especially in diseases of the genito-urinary tract. It is regarded as cooling, diuretic, tonic, and aphrodisiac, and is used in South Europe as an aperient and diuretic. The action of the drug on the mucous membrane of the urinary tract is stated to resemble that of buchu leaves and uva-ursi flowers. The drug undoubtedly has diuretic properties. On account of the spiny fruits, bicycle tyres are liable to be punctured if wheeled over land where this weed is prevalent.

" Geeldikkop '

Watt and Breyer-Brandwijk (*9*) give the following account of this plant, which is the cause of "geeldikkop" (dikgeel) among small stock in South Africa. This condition is characterized by oedema of the head, fever, and jaundice.

"Geeldikkop was first described by Hutcheon (*10*), who thought that it was primarily a derangement of the liver, though one of his assistants, Elley (*11*), later expressed the opinion that the oedema was the primary lesion. The symptoms and *post-mortem* findings have been described in great detail by Hutcheon (*10, 12*), Dixon (*13, 14*), and Theiler (*15*).

Symptoms

"Fever is an early symptom, sometimes being evident before any other sign, but most commonly occurring after the onset of the head swelling.... The sheep, meanwhile, is dull and dejected, with hanging head and drooping ears. Dixon (*13*) states that one of the earliest signs is catarrh of the eyes and nose and infection of the conjunctiva. The sheep refuses to eat and seeks shade. Sometimes an extreme degree of restlessness ushers in the disease. In Theiler's feeding experiments, these symptoms appeared in from nine to fifteen days, though farmers state that they develop within forty-eight hours. 'In some cases the animals stand continuously with the head bent rigidly backwards, the eyes staring vacantly into space. In other cases the patient stands with its head pushed against the kraal wall' (Paine) (*16*). Theiler (*15*) states that the rigid backward bending of the head is seen most commonly in cases which are restless.... The swelling from which the disease receives its name then begins to appear about the head, affecting usually the upper lips and nostrils first, then the ears, then the dorsum nasi and forehead, infraorbital regions, cheeks, masseter region, chin, and finally the submandibular space. According to farmers, the swelling sometimes affects the legs, and Hutcheon (*17*) records that he has seen shedding of the fleece and inflammation of the coronary band or

cushion. The infiltration is at first clear, later yellow. The swellings to begin with are warm and painful, and the sheep scratches them or taps them with the fore leg. Shaking of the head and grinding of the teeth are regular features, and catarrh of the nose and eyes is common. Often the fluid transudes from the swollen areas. The swelling lasts for three to five days and then begins to disappear. The skin now becomes hard and dry and the lips and ears lose their pliability. The drying-out process takes about a week, and leads to necrosis of the skin to a varying degree. The skin also cracks, and purulent sores result. The necrosis is most marked in the ears. From the fourth to the tenth day.... a lemon-yellow coloration of the mucosae, conjunctivae, and sclerae appears. The colour deepens gradually to a green-yellow. Often, in fatal cases, the icterus increases in severity, the temperature meanwhile falling by lysis till the animal collapses. Occasionally, affected sheep suffer from lameness followed by a malformation of the hoofs resembling that of styfsiekte of cattle. Death, in experimental cases, occurred in eleven to thirteen days as a rule. Affected animals show marked anorexia and emaciate rapidly. According to Dixon (*13*) they usually die in a comatose state.

Post-mortem appearance

" *Post mortem,* the carcass is usually greatly emaciated and there is a marked yellow coloration of the visible mucosae and of the conjunctivae. In opening the carcass, all the tissues and tissue fluids are found to be yellow, especially any fat which has persisted. The intestines contain no bile, but the gall-bladder, bile ducts, and biliary ducts are distended with it. Indeed, in one of Theiler's cases, the gall-bladder had ruptured before death. The liver is normal in size, yellow to green in colour, often saffron-coloured, and soft in consistence. Dixon (*13*) and Hutcheon (*12*) state that there is catarrh of the small intestine and hepatic duct, but Theiler (*15*) did not find this, but mentions that the mucous membrane of the small intestine was occasionally injected in some places. The kidney and spleen are usually slightly larger than normal but show no structural change, apart from apparent necrosis of cells containing bile pigment. The heart and lungs are normal, except for pigmentation.

Aetiology

" The disease in the early days was ascribed to various causes : malarial infection, drinking water when the animal was in a heated state, ingestion of *T. terrestris* L., and ingestion of a grub found on this plant (*12, 13, 16*). *T. terrestris* L. repeatedly came under suspicion, but all experiments, aimed at producing the disease by feeding the plant, failed (*13, 16, 18, 19*). It was, however, noticed that the disease usually occurred on farms where the plant was found, that it was more prevalent in those parts of the affected farms where the plant was abundant, and usually

broke out after a rain followed by a continuous hot wind (*13, 17, 19*). It was also noted that if rain was continuous and the plant remained green, then geeldikkop did not appear (*19*). Theiler (*15*) has proved that the disease results from ingestion of the plant in flower, but, from his observations, is of the opinion that it produces the intoxication only when fed on hot days. This is interesting in relation to the records of Dixon (*13, 19*) and Hutcheon (*17*). Quin (*20*), as a result of experiment, found that green, fresh Tribulus can be fed to sheep with impunity, but that when they are fed on brown wilted plants, 70 per cent. develop geeldikkop.

"In a later publication (*21*), Quin alters his opinion as a result of further experiments. Lambs grazed in paddocks on (*a*) young preflowering plants, (*b*) flowering plants, and (*c*) plants in mature fruiting stage, develop the disease in equal incidence, and after about the same period. He finds that the fresh plant juice and watery extracts of the dried plants are highly toxic to sheep, the symptoms of geeldikkop being noticeably absent. Sheep dosed with plant juice die within a few hours, without symptoms. *Post mortem*, the only change observed is a dark brown coloration of the blood. After the watery extract, sheep show dyspnoea, dark brown discoloration of the conjunctivae, and finally coma, with twitchings and convulsions. *Post mortem*, the striking thing again was the brown coloration of the blood. . . . It would appear, therefore, that the toxic effect of the principle is on the haemoglobin. Direct application of the aqueous extract of the dried plant to corpuscular suspensions or to haemoglobin solutions produces the same change in the absorption spectrum.

"All attempts at transmitting the disease by inoculation of the blood of affected animals, or of the fluid from the swellings, have proved negative (*11, 12, 13, 15, 17, 22*). The condition is neither infectious nor contagious. There seems little doubt, therefore, that geeldikkop is an intoxication following the ingestion of *Tribulus terrestris* L., but the condition presents a most puzzling problem in regard to the mechanism of its production. It appears to be primarily an affection of the liver and of the cutaneous and subcutaneous tissues of the head, and sometimes other parts of the skin free from wool (*15*). Theiler thinks that these two processes may be simultaneous, but that the skin condition is perceptible at an earlier stage of the intoxication than the liver lesion."

According to Steyn (*23*), photosensitization (photobiological sensibility, light dermatosis) plays a most important role in *Tribulus terrestris* poisoning (geeldikkop). Quin and Rimington (*24*) made extensive investigations into the nature of the photosensitizing agent present in the plant. They consider that the agent is phylloerythrin, which is a

plant porphyrin derived from chlorophyll. The nature of the icterogenic factor in "geeldikkop" (tribulosis) is however not known, but is being further investigated (*24*).

This disease has not been recorded in India, but the plant must be considered suspicious and a note of warning, regarding the probable danger of allowing small stock to graze in areas where it is prevalent, is, therefore, essential.

Prevention and treatment

Since only the unpigmented and unprotected or slightly protected portions of the body are affected, the best way to prevent the appearance of photosensitization is to provide ample shade for the animals. Also, whenever practicable, the animals should be allowed to graze during the night and kept in the shade during the day. Unpigmented and unprotected parts of the skin may be covered with sacking. When the appearance of the disease is suspected, the grazing ground should be changed immediately, even though the new pasture be infested with tribulus.

When the disease is manifest the animal may be treated symptomatically, as no specific treatment is known. The affected animal should be kept in the shade. Free incisions may be made under proper aseptic conditions into the swollen parts to relieve pressure on the surrounding tissues. The different stages of skin affections should be treated with astringent and disinfectant lotions and ointments. Artificial feeding may be necessary in some cases (*23*).

Constituents

The plant was analyzed and found to contain a substance of an alkaloidal nature. The fruit is said to contain an aromatic principle which gives a fragrant odour when burnt. It also contains an alkaloid in traces, 3·5 per cent. of a fixed oil consisting mainly of unsaturated acids, an essential oil in very small quantities, resins, and fair amounts of nitrates (*25*). More recent work has shown the presence of a glucoside, a starch-splitting enzyme, and a peroxidase (*26*).

An aqueous solution of the tartrate of the alkaloid was passed through preliminary pharmacological tests. It produced a slight rise of blood pressure and an appreciable increase in the kidney volume. Further study could not be carried out owing to the very small yield of the crude alkaloid. The aqueous solution after removal of the alkaloid was found to contain sugars, etc., but no physiologically active substance.

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Family XIX.—RUTACEAE

(Rue Family)

Botanical characters

Shrubs or trees, rarely herbs, glandular and aromatic. Leaves opposite or alternate, simple or compound, exstipulate, dotted with pellucid oil glands. Flowers usually regular and bisexual, in cymes or panicles. Calyx of 4–5 small lobes or sepals. Petals 4–5. Stamens 4–5 or 8–10, many in *Citrus* and *Aegle*; filaments usually free, inserted around a crenate or lobed, sometimes elongate disc; anthers introrse. Ovary usually of 4–5 free or connate carpels; ovules usually 2 in each cell. Fruit a capsule, berry or drupe, or of 1–4 capsular cocci. Seeds often solitary in the cells.

Distribution

In tropical and temperate regions, especially in Australia and South Africa.

Economic and toxic aspects

Citrus is the most important genus of the family and yields a number of fruits, such as oranges (*C. aurantium* Linn.), grapefruit [*C. maxima* (Burm.) Merr., syn. *C. decumana* (Linn.) Murr., and var.], lemon, citron, and sweet and acid limes (*C. medica* Linn. and vars.). Citric acid is found in most species of this genus and various products are obtained from oranges, such as candied peel, the perfume bergamot, etc. The manufacture of marmalade from the sour varieties constitutes an important industry. The pulp of the ripe fruit of 'bael' (*Aegle marmelos* Corr.) furnishes a delicious refreshing drink ('sharbat') in hot weather. This fruit is well known in India for its palliative and soothing properties in chronic diarrhoea and dysentery. The pulp of the ripe fruit of *Feronia elephantum* Corr.*, the elephant or wood apple, is made into a chutney with sugar and salt, and relished in India. *Atalantia monophylla* DC., an evergreen shrub with axillary corymbs of white flowers, is occasionally cultivated in gardens. The strong-smelling gas plant (*Dictamnus albus* Linn.) is also occasionally grown for ornamental purposes. The leaves and capsules of this plant are, on contact and subsequent exposure to sunlight, liable to produce dermatitis in susceptible persons. The Chinese myrtle [*Murraya paniculata* (Linn.) Jack, syn. *M. exotica* Linn.], with fragrant white flowers, occurs both in a wild state and under cultivation in India. It contains

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* According to Airy-Shaw (*Kew Bull.*, 1939, No. 6, p. 293), this plant should be called *Limonia acidissima* Linn.

the glucoside murrayin (*1*). The leaves of the curry-leaf tree (*M. koenigii* Spreng.) are stomachic and are used as a flavouring agent in curries. Twigs of some species of *Zanthoxylum*, especially those of the 'tejbal' (*Z. alatum* Roxb.), are used as toothbrush sticks on account of their cooling and deodorant effects. Several other plants of the family are used in medicine. Jaborandi (*Pilocarpus juborandi* Holmes) and buchu [*Barosma betulina* (Thunb.) Bartl. & Wendl. *f.*] are foreign medicinal plants of repute; the former contains pilocarpine as its principal alkaloid, which is a powerful diaphoretic. It is dangerous to horses when given subcutaneously in doses exceeding 5 grains, but atropine is an effective antidote for it. Buchu leaves act as a mild diuretic, and contain a volatile oil, a glucoside, and a bitter principle. The root-bark of *Toddalia asiatica* (Linn.) Lam. (*T. aculeata* Pers.), a rambling shrub of the subtropical Himalayas, Western and Southern India, etc., is highly esteemed in indigenous medicine as a diphoretic, antiperiodic, carminative, stomachic, and as a tonic. It contains the alkaloid berberine, a bitter substance, an essential oil, and tannins.

Skimmia laureola Sieb. & Zucc. *ex* Walp. is believed to be poisonous to goats and contains about 0·5 per cent of alkaloids of which skimmianine is one of the chief constituents. Skimmianine from *S. japonica* Thunb., a foreign plant, has been found to be poisonous to rabbits and frogs. *Ruta graveolens* Linn. and its essential oil (oil of rue) have been used in medicine as well as for criminal abortion both in India and abroad. This plant has a strong disagreeable odour and, if much handled while fresh, produces vesication of the skin. A glucoside named rutin is also present in the plant. Some of the plants of this family, such as *Zanthoxylum alatum* Roxb., *Z. hamiltonianum* Wall., and *Acronychia pedunculata* (Linn.) Miq. (*A. laurifolia* Blume), are used as fish poisons.

Bitter, acrid, tonic, sialagogic, carminative, antipyretic, antispasmodic, and antiperiodic properties are found in some of the plants of this family. The presence of an aromatic or acrid essential oil is a characteristic feature of the family.

The members of this family have been found to contain: (*a*) *alkaloids*, such as pilocarpine, pilocarpidine, *iso*pilocarpine, pilosine, skimmianine, artrarine, berberine, homochelidonine, xantherines, toddaline, toddalinine, etc., (*b*) *saponins*, (*c*) *glucosides*, such as barosmin, murrayin, rutin, hesperidin, etc., (*d*) *bitter substances*, such as those found in citrus, etc., and (*e*) *essential oils*, such as oils of bergamot, lemon, orange, neroli, citrus, rue, skimmia, zanthoxylum, etc.   *Constituents*

KEY TO THE GENERA*

A. Herbs, sometimes shrubby below. Cells of the ovary more than 2-ovuled. Fruit capsular .. .. .. 2. *Ruta.*

B. Shrubs or trees. Ovules 1–2 in each cell.

I. Usually armed. Leaves 3-foliolate or imparipinnate. Fruit-carpels capsular .. .. .. 4. *Zanthoxylum.*

II. Unarmed. Leaves 1- rarely 3-foliolate. Fruit syncarpous.

a. Petals 4. Stamens 8. Fruit 4-celled .. 1. *Acronychia.*

b. Petals and stamens 4–5 each .. .. 3. *Skimmia.*

1. ACRONYCHIA Forst.

(From *akron*—tip, and *onux*—a claw; referring to the curved points of the petals.)

Botanical characters — Unarmed trees. Leaves opposite or alternate, 1- rarely 3-foliolate; leaflets entire. Flowers yellow, in peduncled corymbs, polygamous. Calyx 4-lobed, imbricate. Petals 4, spreading, revolute, valvate. Stamens 8, inserted under a thick 8-angled tomentose disc, the alternate longer. Ovary sunk in the disc, tomentose, 4-celled; style terminal; stigma 4-grooved; ovules 2 in each cell, superposed. Fruit a 4-celled drupe, or 4-valved loculicidal capsule. Seeds often extruded from the carpels.

Distribution — In tropical Asia, Australia, and the Pacific Islands.

Acronychia pedunculata (Linn.) Miq.

A. laurifolia Blume, Fl. Brit. Ind., I, 498.

(Claw-flowered Laurel, Laka Wood)

Vernacular names: Kanarese—Bhutali, Sonemau; Malayalam—Muttanari, Vidu-kanalei; Tamil—Kattu-kanni, Muttanari; Uriya—Madhugodiyamado.

Botanical characters — A small tree. Leaves 1-foliolate; leaflets 3–7 in., elliptic-oblong, obtuse or mostly obtusely acuminate, glabrous, with rather irregular and finely reticulate venation. Corymbs axillary, 3–5½ in., including the long peduncles. Flowers fragrant, yellowish-white; petals $\frac{1}{5}$ in., linear, revolute, bearded at the base within. Fruit $\frac{2}{5}$ in. diam., somewhat obovoid with depressed or apiculate top, 4-sided or grooved, pubescent, very aromatic.

Distribution — Found in Dehra Dun, Konkan, North Kanara, the hill forests of the Western Ghats of Madras Presidency up to an altitude of 6,000 ft., South Deccan slopes, Northern Circars, Orissa, Sikkim 3,000 to 4,000 ft., Khasia Hills up to 4,000 ft., Assam, and Chittagong.

Toxicity — Pammel (2) reports it to be a fish poison.

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* *Pilocarpus jaborandi* Holmes, a foreign plant, is also discussed in this family.

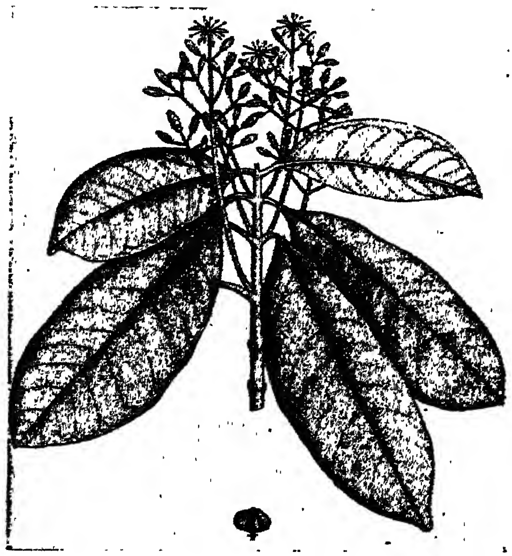

FIG. 42. *Acronychia pedunculata* (Linn.) Miq.

PILOCARPUS Vahl

(From the Greek *pilos*—a cap, and *karpos*—a fruit; from the shape of the fruit.)

Pilocarpus jaborandi Holmes

(Jaborandi, Pilocarpus)

Uses

This foreign plant is used in medicine as a diaphoretic.

Constituents

The leaves contain about 0·72 per cent of total alkaloids consisting of pilocarpine, *iso*pilocarpine, and pilocarpidine (*3*). They also contain 0·5 to 1·0 per cent of an essential oil, consisting of methyl nonyl ketone and some hydrocarbons (*4*).

Pharmacological action

Pilocarpine stimulates the secretions of the salivary, lachrymal, gastric and other glands. It also stimulates the parasympathetic terminations in the involuntary muscles, *e.g.*, of the alimentary canal, bronchi, spleen, bladder, ureters, etc. The central effect of pilocarpine is unimportant. In mammals it quickens the rate of heart beat.

The other two alkaloids, *iso*pilocarpine and pilocarpidine, differ only in the degree of their action, pilocarpine being the strongest and pilocarpidine the weakest (*5*).

In large doses pilocarpine produces diarrhoea and paralysis of the central nervous system. In debilitated individuals even therapeutic doses may produce very serious secondary effects, such as a clouded brain, disturbance of vision, weakness of heart, and profuse bronchial secretion. Death results either from paralysis of the heart or oedema of lungs.

Treatment

Atropine is a physiological antidote to pilocarpine. The usual methods of treatment for alkaloidal poisoning should be employed.

Substitutes in medicine

The following species of *Pilocarpus* have been used as substitutes of *P. jaborandi*, *viz.*, *P. microphyllus* Stapf, *P. pennatifolius* Lem., *P. selloanus* Engl., and *P. trachylophus* Holmes.

2. RUTA (Tourn.) Linn.

(From the Latin *ruta*—rue.)

Botanical characters Strong-smelling herbs, sometimes shrubby below. Leaves alternate. Flowers in terminal corymbs, cymes or panicles, greenish or yellow. Calyx persistent. Petals concave, often toothed or ciliate, imbricate. Stamens 8–10, the alternate shorter. Disc thick, 8–10-glandular or -pitted. Ovary sessile, deeply 3–5-lobed and -celled; style central, basilar. Capsule 4–5-lobed; lobes indehiscent or dehiscing at the apex, many-seeded. Seeds angled; albumen fleshy.

Distribution Chiefly in the Mediterranean region and Western and Central Asia.

Economic and toxic aspects Plants of this genus are acro-narcotic. The leaves act as a rubefacient and as an emmenagogue, and the seeds have antispasmodic and anthelmintic properties.

KEY TO THE SPECIES

a. Flowers 4-merous. Filaments glabrous	.. ..	1. *R. graveolens, var. angustifolia.*
b. Flowers 5-merous. Filaments pilose	.. ..	2. *R. tuberculata.*

1. Ruta graveolens Linn., var. angustifolia Hook. *f.*

Fl. Brit. Ind., I, 485.

(Ave Grace, Common Rue, Countryman's Treacle, Garden Rue, Herb Grace, Herb of Grace, Herb Repentance, Herb of Repentance, Rue)

Vernacular names: ARABIC—Aruda, Fejan, Fidjel; BENGAL—Ermul, Ispund; CENTRAL PROVINCES—Sitab; DECCAN—Pismarum, Sadaf, Satari; GUJERAT—Satapa; HINDI—Pisamarum, Sadab, Satari; KANARESE—Havunanju, Nagadali, Sadabu, Sadapa; MARATHI—Satapa; PERSIAN—Sudab; PUNJAB—Katmal, Sudab; SANSKRIT—Gucchapatra, Pitapushpa, Sadapaha, Sarpadanshta, Somalata, Vishapaha; TAMIL—Aruvadam, Arvada, Pambukolli; TELUGU—Aruda, Sadapa; TULU—Sadapu; URDU—Sudah; URIYA—Maruya.

Botanical characters A small branching undershrub, 2–3 ft. high. Leaves petioled, decompound; segments various. Flowers in divaricately spreading corymbs; bracts lanceolate. Sepals triangular, acute. Petals oblong-obovate, pectinate, abruptly clawed. Capsule obtuse, shortly pedicelled.

Distribution Cultivated in Indian gardens for the medicinal properties of its leaves and seeds.

The following account refers to *R. graveolens* proper.

Uses and properties Rue was held in great esteem by the ancient Greeks and Romans, who considered it to be a valuable resolvent, diuretic, and emmenagogue. They attributed many fanciful virtues to it. The plant is sometimes placed in beds to keep off insects. The variety *angustifolia* is stated to be largely used in indigenous medicine as a fumigant in infant catarrh.

Oil from *R. graveolens* has been used for several purposes in Western medicine; given internally, it acts as an emmenagogue in

FIG. 43. *Ruta graveolens* Linn.

doses of two to five drops, and, applied externally, it acts as a rubefacient. In larger doses, however, it acts as an abortifacient and produces irritant symptoms. The medicinal dose of powdered leaves is twenty to forty grains. The Indian variety appears to be a perfect substitute and finds similar uses in indigenous medicine. It is also used as a tonic, anthelmintic, stomachic, etc.

Constituents

A volatile oil (the oil of rue) is obtained to the extent of about 0·06 per cent by the distillation of the fresh herb in steam. It has a pale-yellow or greenish colour when fresh, but becomes brown on keeping. It consists mainly of the ketone, methyl-n-nonyl ketone, with about 5 per cent of methyl-n-heptyl ketone *(6)*. It has a strong disagreeable

odour and an acrid and nauseous taste. The volatile oil is said to be the active principle of the plant; it occurs in smaller quantities in the leaves and the roots, but in somewhat greater amounts in the seeds. A glucoside rutin and a cumarin-like odoriferous principle have also been isolated from the plant (*7*). Rutin or rutoside is said to have a low toxicity (*8*).

Poisoning

The oil and the herb have been frequently employed to produce criminal abortion both in Europe and in India, though in ordinary doses it appears to have no effect on the uterus. In large doses it is an acro-narcotic poison, causing vomiting, prostration, with a feeble, slow pulse, and coldness of the extremities. Poisoning by the oil is characterized by gastro-enteritis (*7*), swelling of the tongue, and salivation. The leaves, if much handled when fresh, produce redness, swellings, and even vesication of the part with which they come in contact.

2. Ruta tuberculata Forsk.

Fl. Brit. Ind., I, 485.

Vernacular name : Arabic—Fidjel.

Botanical characters

Stem erect or ascending, branched, woody, minutely glandular, glabrous. Leaves ½–1 in. long, linear-oblong or somewhat spathulate, pustular and pubescent, base narrowed into the petiole. Cymes dichotomously branched. Flowers ¼ in. across. Petals ⅛–⅙ in. long, yellow, entire. Capsule 5-lobed, 5-celled, tubercled, often with 2 seeds in each cell.

Distribution

Common in the hills of Sind and Baluchistan, extending westwards to Egypt and Algeria.

Uses and properties

It is used similarly to *R. graveolens* Linn.

3. SKIMMIA Thunb.

(From *skimmi*, a Japanese word signifying a harmful fruit.)

Botanical characters

Unarmed, glabrous, strong-scented shrubs. Leaves alternate, simple, entire. Flowers polygamous, crowded in terminal panicles. Calyx 4–5-lobed, imbricate. Petals 4–5, oblong. Disc obsolete. Stamens 4–5, imperfect in the female flower. Ovary obovoid, 2–5-celled; style terminal or 0; stigma capitate, 2–5-lobed; ovules solitary. Drupe ovoid, fleshy, with 2–5 cartilaginous 1-seeded stones.

Distribution

Himalayas, China, and Japan.

Skimmia laureola Sieb. & Zucc. *ex* Walp.

Fl. Brit Ind., I, 499.

Vernacular names. GARHWAL—Nair; JAUNSAR—Gurl-pata, Kathurchara; KUMAON—Gurl-pata, Nehar: KUNAWAR—Patrang; LEPCHA—Timburnyok; NEPAL—Chumlani; PUNJAB—Barru, Ner, Shalangli, Shashra; RANIKHET—Naira.

Botanical characters

Shrub, 3–8 ft. high. Leaves 3–6 in., oblong-lanceolate or oblanceolate, crowded near the ends of branches. Flowers about $\frac{1}{3}$ in. diam., yellow or white, 1- or 2-sexual, in compact, erect, terminal panicles

FIG. 44. *Skimmia laureola* Sieb. & Zucc. *ex* Walp.

$1\frac{1}{2}$–2 in. long. Calyx 5-lobed, persistent. Ovary 3-celled. Drupe red, $\frac{1}{2}$–$\frac{3}{4}$ in. long, containing 2, sometimes 1 or 3 seeds.

Distribution

Found in the temperate regions of the North-Western Himalayas from Kashmir to Kumaon at altitudes of 6,000 to 10,000 ft. Two other closely related species occur in the Eastern Himalayas.

Uses and properties

In Kashmir, the leaves are used as an incense. The shepherds there believe the plant to be poisonous to goats.

Constituents

The dried leaves are found to contain about 0·5 per cent of alkaloids of which skimmianine has been identified as one of the chief constituents (*9*). The yield of essential oil from the leaves varies from 0·5 to 1·0 per cent, the constituents of the oil being β-phellandrene, α-pinene, linalyl acetate, linalol, azulene, etc. (*10*). Skimmianine from *S. japonica* Thunb. has been found to be poisonous to rabbits and frogs (*11*).

4. ZANTHOXYLUM Linn.

(From the Greek *xanthos*—yellow, and *xylon*—wood.)

Botanical characters

Shrubs or trees, usually armed with stout prickles. Leaves alternate, 3-foliolate or imparipinnate, with opposite or alternate often oblique leaflets. Flowers small, in axillary or terminal peduncled cymes, polygamous. Calyx 3–8-fid, rarely 0. Disc small or obscure. Stamens usually 3–8, hypogynous, reduced to scales in the female flowers. Ovary of 1–5 oblique 1-celled carpels, rudimentary in the male flowers ; styles sublateral. Fruit of 1–5 globose, coriaceous or fleshy, 1-seeded carpels dehiscing ventrally ; endocarp horny.

Distribution

In tropical and subtropical regions.

Economic and toxic aspects

There are about a dozen representatives of this genus, which are found in the tropical and subtropical regions of India, and at least eight of them are used in indigenous medicine. The more important of these are *Z. alatum* Roxb., *Z. budrunga* Wall., and *Z. limonella* (Dennst.) Alston (*Z. rhetsa* DC.). A few of them are known to contain an essential oil in the capsule, but there is no doubt that the same is present in all of them. The essential oil obtained from *Z. schinifolium* Sieb. & Zucc., a foreign species, has been found to be almost as potent as the oil of chenopodium to ascaris of pigs *in vitro* in warm Ringer solution (*12*). Most of the species of *Zanthoxylum* so far investigated have been found to contain one or the other of the following alkaloids : berberine, xantherines, artarine, l-canadine-α-methochloride, and γ-homochelidonine.

Besides *Z. alatum* Roxb. and *Z. hamiltonianum* Wall. which are described below, the fruits and seeds of *Z. acanthopodium* DC. and *Z. budrunga* Wall. respectively are said to be used in Assam for poisoning fishes.

KEY TO THE SPECIES

a. A small tree or an erect shrub. Rachis of leaf winged. Flowers apetalous .. .. .. 1. *Z. alatum*.

b. Scandent shrubs. Rachis of leaf not winged. Flowers polypetalous .. .. .. 2. *Z. hamiltonianum*.

1. Zanthoxylum alatum Roxb.

Fl. Brit. Ind., I, 493.

Vernacular names: ARABIC—Fagireh; BUSHAHR—Timbar, Timru; BENGAL—Gaira, Nepali-dhania, Tun; HINDI—Darmar, Nipali-dhanya, Tejbal, Tejphal, Tezmal, Timbur, Timur, Tumru; JAUNSAR—Temru, Timbar, Timru; KANARESE—Jimmi, Tumburudu; KUMAON—Timru, Timur; LEPCHA—Sung-rukung; NEPAL—Bale-timur, Timur; PERSIAN—Kababe-jahanulsha; PUNJAB—Kababa, Tejbal, Tezbal, Timar, Timbar, Timmal, Timru; SANSKRIT—Tumburu; UNITED PROVINCES—Jwaran-tika, Tejbal, Timur; URDU—Kababe; URIYA—Tundopoda.

Botanical characters

A shrub or small tree, armed on the branchlets, leaf-rachis and midrib with broad flattened prickles, those on the older branches usually with a conical corky base. Leaves imparipinnate, rachis usually

FIG. 45. *Zanthoxylum alatum* Roxb.

winged. Leaflets 2–6 pairs, opposite and a terminal, $1\frac{1}{2}$–3 by $\frac{2}{5}$–1 in., lanceolate, more or less serrate, sessile. Flowers yellow, in dense

pubescent lateral panicles 2–6 in. long, polygamous. Calyx-segments 6–8. Petals 0. Stamens 6–8. Fruit of 1–3 (rarely 4) small, red, globose drupes, the size of a peppercorn, ultimately splitting into 2 valves and exposing the solitary black shining seed.

Distribution

Found in the hot valleys of the subtropical Himalayas from the Trans-Indus area eastwards to Bhutan up to an altitude of 7,000 ft.; also in the Khasia Hills between 2,000 and 3,000 ft., and in the hills of Ganjam and Vizagapatam at about 4,500 ft.

Toxicity

This plant possesses a pungent aromatic odour and taste. According to Brandis, the bark is used for killing fish, while Atkinson reports that its fruit also is used for the same purpose (*13*).

Constituents

The fruit contains about 1·5 per cent of an essential oil consisting chiefly of l-α-phellandrene with small amounts of linalol, etc. (*14*). The bark contains a bitter crystalline principle which is identical with berberine. It also contains a volatile oil and some resins (*13*).

2. Zanthoxylum Hamiltonianum Wall.

Fl. Brit. Ind. I, 494.

Vernacular names: ASSAMESE—Tezmoi, Tezmuri; NAGA—Changre; NEPAL—Parpar-timur, Purpuray-timur.

Botanical characters

A large evergreen scandent shrub, armed on the branches, leaf-rachis and sometimes on the midrib with recurved prickles, those on the old branches with more or less cylindrical and corky bases; branches and leaf-rachis glabrous or more or less pubescent or velvety. Leaves 6–15 in. long, imparipinnate, rachis terete. Leaflets 2–3 pairs, opposite and a terminal, the lateral 3–7 by $1\frac{3}{4}$–3 in., ovate, oblong or elliptic, abruptly or gradually narrowed into a broad notched apex, rounded at base, glossy, usually entire. Flowers about $\frac{1}{5}$ in. diam., dull-white, shortly pedicelled, in slender puberulous axillary fascicled cyme-bearing panicles $1\frac{1}{2}$–3 in. long. Petals 4–5. Fruiting carpels 2–4 (rarely 5), $1\frac{1}{2}$ in. across, globose, somewhat compressed, pitted outside.

Distribution

Fairly common throughout Assam in low-level forests, except in the Khasia and Jaintia Hills.

Uses

The fruit is used in indigenous medicine for its aromatic and stimulant properties.

Toxicity

The roots are used as a fish poison by cutting them into pieces and putting in a bag which is thrown into a pond containing fish. The action is fairly rapid; the fish become stupefied and their eyes congested in about half an hour (*15*).

In the laboratory, a boiled fresh solution of the roots killed 100 anophelines in 7 minutes. It acted equally on anophelines and culicines, but had no action on pupae. A dilute solution, consisting of 1 oz of roots added to 1 pint of water and boiled for 15 minutes, lost its potency after 3 days and became inert on the fifth day (*15*).

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Family XX.—SIMAROUBACEAE

(Quassia and Ailanthus Family)

Botanical characters

Trees or shrubs, usually with bitter bark. Leaves alternate; often very large, pinnate, rarely simple, 2-foliolate in *Balanites*, not dotted; stipules 0 or deciduous. Flowers 1-sexual or polygamous, rarely hermaphrodite, small. Calyx 3–5-lobed. Petals 3–5, rarely 0, hypogynous. Stamens as many or twice as many as the petals, rarely indefinite, inserted at the base of the disc; filaments free, often with a scale at the base. Ovary free, 1–6-celled, usually deeply lobed, less often entire; styles 2–5, free or united; ovules usually 1 in each cell. Fruit drupaceous, capsular or occasionally samaroid, usually of 2–6 distinct carpels. Seeds usually solitary, generally albuminous.

Distribution

In tropical and subtropical regions.

Economic and toxic aspects

The bark of the plants belonging to this family is almost always bitter and nonastringent. Bitter substances have been found to occur in most of the genera. A few species yield useful timber. Quassia (*Picrasma excelsa* Planch.), an important pharmacopoeial drug, has been used as a bitter and as an anthelmintic against threadworms. It is also a useful insecticide. Four species of *Picrasma* are found in India; of these *P. javanica* Blume, var. *nepalensis* (Benn.) Badhwar (*P. nepalensis* Benn.) of Assam has been reported to be used as a larvicide in that province. *Samadera indica* Gaertn., of Western and Southern India, furnishes the niepa bark of commerce, which contains a bitter principle and is used as a febrifuge. *Quassia amara* Linn. of America, the original source of the quassia wood used in pharmaceutical practice, is grown in gardens. Saponins have been found to occur in *Balanites roxburghii* Planch., a plant employed as a fish poison and also in indigenous medicine.

Ailanthus excelsa Roxb. is indigenous to the Northern Circars, and is often planted in various parts of India. The bark and leaves have a reputation as tonics and are used for a variety of purposes in indigenous medicine. The ground bark is also used in indigenous veterinary practice. Ailanto or the tree of heaven [*Ailanthus altissima* (Mill.) Swingle, syn. *A. glandulosa* Desf.] is an introduced tree cultivated in the Punjab; it contains an essential oil, a bitter substance, and a saponin.

Constituents

The members of this family contain: (*a*) *bitter substances*, such as quassiin, castelamarin, picrasmin, simarubin, etc., (*b*) *glucosides*, such as castelin, samaderin, etc., and (*c*) *saponins*.

KEY TO THE GENERA

A. Ovary deeply divided. Leaves unequally pinnate.

- I. Stamens twice as many as the petals. Fruit samaroid .. .. 1. *Ailanthus*.
- II. Stamens as many as the petals. Fruit drupaceous.
  - *a*. Flowers panicled. Disc thick, entire. Styles connate in the middle .. .. 4. *Picrasma*.
  - *b*. Flowers compoundly cymose. Disc 4-lobed. Styles nearly free .. .. 3. *Brucea*.

B. Ovary entire. Leaves 2-foliolate. Stemspiny .. 2. *Balanites*.

1. AILANTHUS Desf.

(From *ailanto*, meaning tree of heaven, the native name of one of the species in the Moluccas.)

Botanical characters

Lofty trees. Leaves unequally pinnate. Flowers polygamous, bracteolate, in terminal or axillary panicles. Calyx 5-fid; lobes imbricate. Petals 5, valvate. Stamens 10 in the male, 2–3 in the bisexual and 0 in the female flowers, without scales. Ovary 2–5-partite; styles connate; ovule 1 in each cell. Fruit of 1–5 samaras; wing large, membranous.

Distribution

In India, China, Japan, and Australia.

Ailanthus altissima (Mill.) Swingle

Ailantus glandulosa Desf., Fl. Brit. Ind., I, 518.

(Ailanto, Chinese Sumac, Japan Varnish Tree, Stinking Cedar, Tree of Heaven)

Botanical characters

A large deciduous tree producing abundant root-suckers. Leaves up to 3 ft. long; leaflets very numerous, divided very unequally by the midrib, usually with 1–3 pairs of glandular teeth near the base. Flowers small. Petals woolly-tomentose inside. Filaments exserted, several times exceeding the anthers. Samara twisted at the top, about $1\frac{1}{4}$ by $\frac{1}{3}$ in.

Distribution

Met with in the hills of Northern India; most probably introduced from Japan. Extensively cultivated on the continent of Europe as an avenue tree.

Toxicity

The bark of this tree is an active vermifuge and in powdered form is a narcotic with a strong nauseating odour. It exercises a powerful depressing influence on the nervous system similar to that of tobacco. These depressing effects appear to be due to the presence of a volatile oil, the resin having no such influence. " Meehan states that it interposes the spread of the rose-bug, to which the tree is destructive " (*1*). Cases of irritation due to the handling of the plant and the flowers are recorded by Pammel (2). He also quotes cases where symptoms of chronic gastritis were observed due to an accumulation of the leaves in well water.

Constituents The flowers contain an essential oil (*3*). The bark contains 0·005 per cent of a very bitter crystalline substance named ailanthin and probably also a glucoside and a saponin (*4*).

2. BALANITES Delile

(From the Latin *balanus*—an acorn, *balanitis*—acorn-shaped; referring to the ovary half-sunk in the disc.)

Botanical characters Thorny shrubs or small trees. Leaves 2-foliolate; leaflets coriaceous, entire. Flowers greenish, in small axillary cymes, fragrant. Sepals 5, concave, imbricate, deciduous. Petals 5, imbricate. Stamens 10, inserted in the furrows at the base of the disc which is 10-lobed below. Ovary entire, 5-celled, or by suppression 1-celled, half-sunk in the disc; ovules 1 in each cell. Drupe fleshy, oily, with a very hard 5-angled, 1-celled and 1-seeded stone.

Distribution In northern and tropical Africa and tropical and western Asia.

Balanites roxburghii Planch.*

Fl. Brit. Ind., I, 522.

Vernacular names: ALWAR—Hingat; ARABIC—Elheglyg, Heghelig: BENGAL—Hingon; CUTCH—Hinganbet; DECCAN—Hingan, Hinganbet; GOND—Garrah: GUJERAT—Egorea, Hinger, Hingoriyum, Igorea, Ingoriyo; HINDI—Hingan, Hingen, Hingol, Hingot, Hingota, Hingu, Ingua; KANARESE—Ingalarade, Ingalare, Ingalukke; KHARWARI—Ingun; MALAYALAM—Nanchunta, Nanjunta; MARATHI—Hingan, Hingana, Hingane; PORBANDAR—Hingoriyun, Ingoriyan, Ingoriyun; SANSKRIT—Ingudi, Ingudam; TAMIL—Nanjunda, Toruvattu; TELUGU—Gara, Garapandu, Gari, Ingudi, Ringri; URDU—Hingot; URIYA—Ingudihala.

Botanical characters A shrub or small evergreen tree, armed with stout axillary thorns which often bear leaves and flowers. Leaflets 1–2 by $\frac{1}{2}$–1 in., elliptic or obovate. Petals slightly larger than the sepals, glabrous without, silky within. Fruit an ovoid drupe $1\frac{3}{4}$–$2\frac{3}{4}$ in. long, faintly 5-grooved, pale-yellow when ripe; pulp $\frac{1}{5}$ in. thick, with an offensive greasy smell.

Distribution Found in the drier parts of India extending from South-East Punjab and Delhi to Sikkim, Bengal, Central India, Bombay Presidency, and South India.

Uses and properties The pulp of the fruit is used in Rajputana for cleaning silk, and the hard nuts are made into crackers after removing the kernel and filling shells with gunpowder. The seeds, fruits, bark, and leaves are used in indigenous medicine as a cathartic and also as an anthelmintic. The

* The Indian plant is very nearly allied to and perhaps only a variety of *B. aegyptiaca* Delile of northern and tropical Africa. Engler and Prantl (Die natürilichen Pflanzenfamilien, V, 3, part 4, p. 355) unite the Indian species with *B. aegyptiaca* which differs in having glabrous petals, and place the genus under Zygophyllaceae.

seeds yield a fixed oil; the corresponding oil prepared from the African plant is said to be used as a purgative. The unripe drupes have strong

FIG. 46. *Balanites roxburghii* Planch.

cathartic properties. The ripe fruit has a sweet but disagreeable pulp surrounding the stone. In Western India, as also in Egypt, it is eaten and, when fermented, is said to yield an intoxicating liquor used by the Africans. The bark is used in several areas in India and by African Arabs as a fish poison.

Constituents

The flesh of the fruit contains about 7·2 per cent of saponins (*5*).

3. BRUCEA J. S. Mill.

(After J. *Bruce*, the African traveller.)

Botanical characters

Bitter trees or shrubs. Leaves unequally pinnate. Flowers in numerous very small cymes collected into axillary panicles. Calyx minute, 4-partite, imbricate. Petals 4, minute, linear, imbricate.

Disc 4-lobed. Stamens 4; filaments naked. Ovary deeply 4-lobed or consisting of 4 entirely free carpels; styles nearly free. Drupes 4, entirely free, ovoid, somewhat fleshy. Seeds exalbuminous.

Distribution In Africa, tropical Asia, and Australia.

Brucea amarissima (Lour.) Merr.

B. sumatrana Roxb., Fl. Brit. Ind., I, 521.

Vernacular name: SINHALESE—Kaputugedi.

Botanical characters A large evergreen shrub. Leaves often more than a ft. long; leaflets in 3–6 pairs with an odd one, ovate-lanceolate, acuminate, coarsely

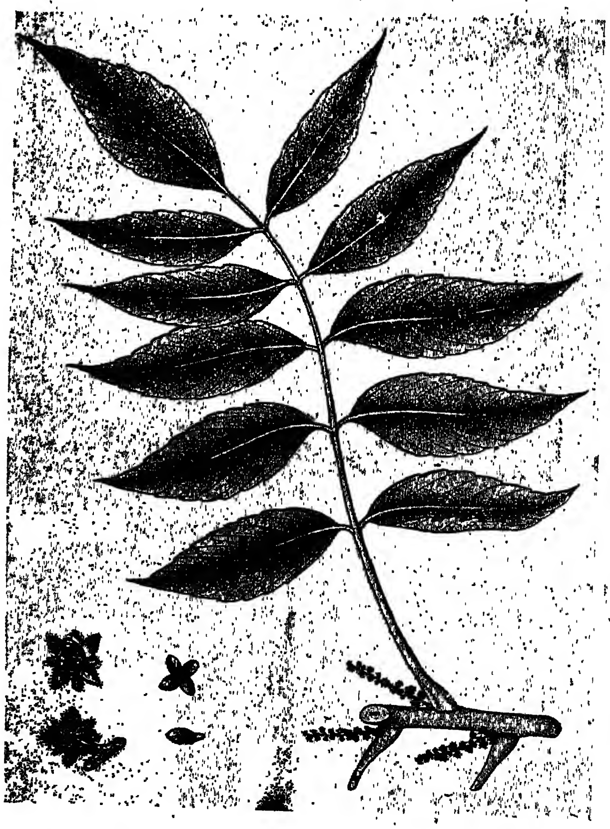

FIG. 47. *Brucea amarissima* (Lour.) Merr.

crenate-toothed, densely pubescent or villous especially beneath. Flowers minute, purple, in little cymes or clusters and forming interrupted

tomentose racemes as long as or shorter than the leaves, usually hermaphrodite. Drupe the size of a small pea, ovoid, black, glabrous.

Distribution

Found in Assam and the Andamans.

Uses and properties

In Indo-China, the seeds are well known for their anthelmintic and antidysenteric properties. Liu Hsiao-Liang (*6*) has studied the action of these seeds. Twenty to fifty unbroken seeds, but with the shells removed, administered to adults in capsules in a single dose or in several divided doses throughout the day, were given by him for amoebic dysentery and found to be very efficacious. The amoebae, according to him, disappeared from the stools of the patients treated by him in the course of one to six days. The toxic symptoms produced by the seeds were nausea, vomiting, abdominal pain, and purging, but they were never severe.

Constituents

An alkaloid brucamarine has been separated from the seeds. Physalis and Bertrand found a bitter glucoside which they called kosamine (*6*).

4. PICRASMA Blume

(From the Greek *pikrasmos*—bitterness; referring to the bitter taste of plants belonging to this genus.)

Botanical characters

Trees or shrubs with very bitter properties. Leaves unequally pinnate. Flowers dioecious or polygamous, in axillary panicles. Calyx minute, 4–5-toothed. Petals 4–5, valvate, often enlarging after flowering. Disc thick, entire. Stamens in males as many as petals, not scaly, hairy, in females often wanting. Ovary 3–5-partite; styles distinct at base and apex, but united in the middle; ovules solitary. Fruit of 1–3 fleshy or coriaceous drupes.

Distribution

Tropical and subtropical regions.

Picrasma javanica Blume, var. nepalensis (Benn.) Badhwar*

P. nepalensis Benn., Fl. Brit. Ind., I, 520.

Vernacular name: GARO—Thigisin; NEPAL—Teju.

Botanical characters

A tree, 20–40 ft. high. Leaflets 7, sometimes 5, $2\frac{1}{2}$–4 by $\frac{3}{4}$–$1\frac{1}{2}$ in., elliptic-lanceolate or obovate-oblong, caudate-acuminate, glabrous, margin waved or wrinkled, entire. Flowers about $\frac{1}{3}$ in. diam., dull-white, 4-merous, in corymbosely branched axillary panicles 2–4 in. long. Fruit of 1–3 subglobose coriaceous black drupes seated on the

* Bennett's *P. nepalensis* differs from *P. javanica* Blume in being a smaller tree having narrower leaflets with longer points to the leaflets; the branches of the panicles are also usually more slender. King (*J. Asiat. Soc. Beng.*, 1893, 62, 228) reduces it to *P. javanica*, but it undoubtedly deserves a varietal rank.

cushion-like disc, and surrounded by the enlarged coriaceous curved petals.

Distribution Found in Nepal and Assam.

FIG. 48. *Picrasma javanica* Blume, var. *nepalensis* (Benn.) Badhwar

Toxicity The young leaves and twigs of this plant are used as a larvicide in Assam.

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Family XXI.—MELIACEAE

(Neem and Mahogany Family)

Botanical characters

Trees or shrubs. Leaves alternate, usually pinnate, exstipulate; leaflets generally oblique at the base. Flowers usually bisexual, in terminal or usually in axillary panicles. Calyx small, 3–6-toothed, -partite, or subentire. Petals 3–6, rarely connate at the base. Stamens 4–12, inserted outside the base of a hypogynous disc; filaments usually united into a tube. Disc sometimes absent, usually annular or tubular. Ovary usually free, 2–5-celled; style simple; ovules 2 in each cell, rarely more or solitary. Fruit capsular, drupaceous or a berry. Seeds sometimes arilled or winged.

Distribution

Widely spread, mostly in the tropics.

Economic and toxic aspects

Several plants of this family are more or less acrid, bitter, and astringent, some are emmenagogue, emetic, and cathartic, some have parasiticidal and insecticidal properties, while others are used for their tonic, stimulant, and antiperiodic principles. Many species yield valuable timber, and that from 'toon' or the Indian mahogany (*Cedrela toona* Roxb. *ex* Rottl.) is stated to be proof against white ants. The mahogany tree (*Swietenia mahagoni* Jacq.) of the West Indies and South Africa yields excellent timber and is planted in gardens, avenues, and in some forest localities in India. Fixed oils are expressed from the seeds of several species, and the one from the neem or margosa tree (*Azadirachta indica* A. Juss., syn. *Melia azadirachta* Linn.) is largely used in medicine for its parasiticidal properties and in skin diseases. The oil from *Carapa procera* DC., a foreign plant, has been stated to be poisonous to insects, and it is likely that the oils obtained from some other plants belonging to this family have insecticidal properties. The leaves of *Azadirachta indica* are used to protect woollen fabrics and books against insects. The seeds of this plant and those of the Persian lilac (*Melia azedarach* Linn.) are poisonous to man and some animals, producing gastro-intestinal irritation and severe purgation; in the case of the latter narcotic symptoms are also produced.

The Indian satinwood or yellowwood (*Chloroxylon swietenia* DC.) of Central and South India contains an alkaloid, chloroxylonine, which is a powerful irritant producing dermatitis when applied to the skin (*1*). A saponin has been isolated from *Walsura piscidia* Roxb., the bark of which is used as a fish poison.

Seeds of *Dysoxylum malabaricum* Bedd. *ex* C. DC. of South India are stated to contain a toxic substance (a nerve poison), dysoxylonic acid. The bark, fruit, and seeds of *Heynea sumatrana* Miq., a foreign plant, contain a toxic acid and a bitter substance. The bark and seed of *Lansium domesticum* Corr., which is cultivated in India, contain a toxic substance named lansium acid, which is a heart poison. The bark of *Sandoricum koetjape* (Burm. *f.*) Merr. (*S. indicum* Cav.), an introduced tree, contains traces of an alkaloid, a slightly toxic bitter substance, and a slightly toxic acid (*2*).

Constituents — The members of this family have been found to contain: (*a*) *bitter substances*, (*b*) *alkaloids*, such as chloroxylonine, flindersine, etc., (*c*) *essential oils*, and (*d*) *toxic substances*.

KEY TO THE GENERA

A. Leaflets usually serrate. Fruit drupaceous.
- *a.* Leaflets pinnate. Disc 0. Seeds exalbuminous .. 1. *Azadirachta*.
- *b.* Leaflets 2–3-pinnate. Disc annular. Seeds albuminous .. .. 2. *Melia*.

B. Leaflets entire. Fruit a shortly tomentose berry. Seeds arillate .. .. 3. *Walsura*.

1. AZADIRACHTA A. Juss.

(From the Persian *azad-darakht*, the name of *Melia azedarach* Linn.)

Distribution — Species 1; believed to be indigenous to South India and Burma.

Azadirachta indica A. Juss.

Melia azadirachta Linn., Fl. Brit. Ind., I, 544.

(Neem or Margosa Tree)

Vernacular name: BENGAL—Nim; BURMA—Baw-tamaka, Kamaka, Tamabin, Thamaka, Thin, Thin-boro-tamakha: CENTRAL PROVINCES—Limbo; DECCAN—Nim; GUJERAT—Danujhada, Kohumba, Libado, Limba, Limbado, Limbra; HINDI—Bal-nimb, Nim, Nimb, Ninb: KANARESE—Bemu, Bevina, Bevu, Kay-bevu, Kaype-bivu, Nimba, Olle-bevu; KOLAMI—Nim; KONKANI—Nim; KUMAON—Betain, Nim; MALAYALAM—Arytikta, Arya-veppu, Nimbam, Pisumarddam, Raja-veppu, Veppu; MARATHI—Balanta-nimba, Kadu-khajur, Limba, Nimbay; PALAMAU—Agas; PERSIAN—Azad-darakht-e-hindi, Neeb, Nib; PUNJAB—Nim; SANSKRIT—Arishta, Nimba, Vishirnaparana, Vranasodhakari, Yavaneshta; SANTAL—Nim; SIND—Nimuri; TAMIL—Arulundi, Kaduppagai, Kinji, Malugam, Niriyasam, Pisidam, Sengumaru, Ukkargandam, Vembu, Veppa, Veppu, Varuttam; TELUGU—Nimbamu, Taruka, Vemu, Veppa, Yappa, Yeppa; TULU—Bevu, Kay-bevu; URDU—Neem; URIYA—Kakopholo, Limbo, Nimbu, Nimo.

Botanical characters — A large glabrous evergreen tree. Leaves pinnate, crowded towards the ends of the branches; leaflets 9–15, 1–3 in. long, subopposite, obliquely lanceolate or falcate, acuminate, coarsely serrate. Flowers white, $\frac{1}{5}$ in. long, in axillary panicles. Calyx 5-fid, divided almost to the base.

Petals 5, ciliolate. Staminal tube toothed at the apex; anthers 10, opposite the teeth and within the tube. Disc 0. Ovary 3-celled; stigma 3-toothed; ovules 2 in each cell, collateral. Drupes ½–¾ in. long, ovoid-oblong, 1-celled, 1-seeded, greenish-yellow when ripe.

FIG. 49. *Azadirachta indica* A. Juss.

Distribution

This tree is said to be indigenous to the Jhelum valley, but this is doubtful. It is often planted all over India and is one of the trees held as sacred by the Hindus.

Uses and properties

Almost every portion of this valuable tree has been used for medicinal purposes from remote antiquity. The bark and the leaves are bitter and are used in the treatment of intermittent fever and as a tonic. The leaves are a household medicine for skin diseases and ulcers, and are considered to have antiseptic properties. They are also largely

employed to protect woollen fabrics and books from insects. The twigs are commonly used as toothbrushes, and parts of the plant are now used in the preparation of modern dentifrices and soaps. The flowers and very young leaves are often collected and eaten as a vegetable either alone or mixed with other vegetables.

The seeds contain about 31 per cent of a fixed, bitter, deep-yellow oil with a strongly disagreeable flavour. This is the margosa or neem oil of commerce which is employed medicinally as an anthelmintic and in skin diseases. While studying the anthelmintic properties of the oil in doses of 1 to 4 drachms, Caius and Mhaskar (*3*) found that it produced occasional diarrhoea, nausea, and general discomfort in maximum doses; both the leaves and the oil proved ineffective in expelling intestinal parasites. There is little doubt that the seeds are poisonous in large doses and would produce symptoms of severe purgation.

Constituents

The seeds contain an amorphous bitter principle and also a crystalline substance, margosopicrin. On boiling the crushed seeds with water a white, nonbitter crystalline substance has also been obtained. The objectionable odour of the oil obtained from the seeds is chiefly due to slightly volatile organic sulphur compounds and also to some fatty acids (*4*). A more recent investigation shows that the odoriferous constituent of the oil is a sulphur-containing liquid, and the bitter principle is a glucoside. The fatty acids have also been found to contain acids of the chaulmoogric-acid series (*4a*).

2. MELIA Linn.

(From the Greek name for the ash tree, *fraxinus*; applied to this genus because of the resemblance in leaves.)

Botanical characters

Trees or shrubs. Leaves 2–3- (or 1-) pinnate. Flowers elongate, in large axillary panicles. Calyx 5–6-partite, imbricate. Petals 5–6, free. Staminal tube cylindric, dilated and laciniate at the mouth; anthers 10, within the tube at its apex, sessile between its laciniae, apiculate. Disc annular. Ovary 5–8-celled; style cylindric, much exceeding the ovary; stigma capitate; ovules 2 in each cell, superposed. Drupe subfleshy; endocarp woody; cells 1-seeded. Seeds albuminous; cotyledons foliaceous.

Distribution

In warmer parts of Asia and Australia.

Melia azedarach Linn.

Fl. Brit. Ind., I, 544.

(Bead Tree, Chinaberry, China Tree, Persian Lilac, Pride of India)

Vernacular names: ALMORA—Betain; ARABIC—Ban, Hab-ul-ban; ASSAM—Thamaga; BENGAL—Ghora-nim, Maha-nim; BURMA—Kamaka, Tamaka;

CENTRAL PROVINCES—Maha-limbo, Maha-nim, Malla-nim, Muhli; DECCAN—Gouli-nim, Gouri-nim; GARHWAL—Denkna; GUJERATI—Bakan-limbodo; HINDI—Bakain, Bakarja, Bakayan, Betain, Deikna, Drek; JAUNSAR—Deknoi; KANARESE—Ara-bevu, Bevu, Bettada-bevina, Chik-bevu, Garuda-bevu, Kad-bevina, Huchu-bevu, Sikka-bevu, Visha-bevu; KOLAMI—Gara-nim; KONKANI—Vilayati-nimb; KUMAON—Dainkan; MALAYALAM—Mala-veppu; MARATHI—Bakana-nimb, Limbara, Vilayati-nimb; MUNDARI—Bakainidaru; NEPAL—Bakain, Bakainu; PERSIAN—Azad-darakht, Bakaen; PUNJAB—Bakain, Chein, Dhek, Dhreg, Drek, Jek, Kachen; PUSHTU—Bakyana; RAMNAGAR—Betun; SANSKRIT—Himadruma, Mahanimba, Parvatanimba; SIND—Bakayun, Drek; TAMIL—Malai-vembu, Malai-veppam, Pisidam, Sigari-nimbam, Tittam; TELUGU—Konda-veppa, Maka-nim, Turaka-veppa, Vetti-veppa. UNITED PROVINCES—Bukain, Dek; URDU—Bakayana.

Botanical characters

A moderate-sized tree. Leaves bi-, occasionally tri-pinnate; pinnae 3–4 pairs, more or less opposite. Leaflets 3–11, opposite or nearly so,

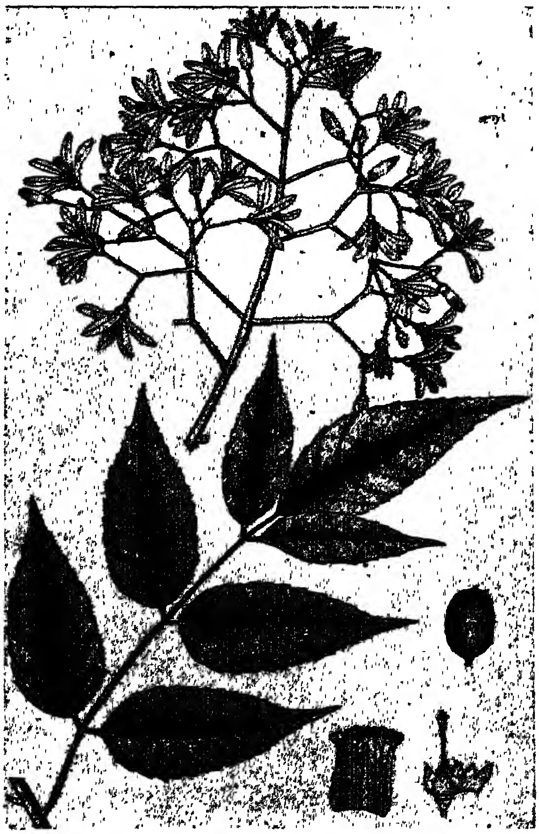

FIG. 50. *Melia azedarach* Linn.

$\frac{1}{2}$–2 by $\frac{1}{3}$–1 in., ovate or lanceolate, slightly inequilateral at the base, acuminate, obtusely serrate, sometimes lobed. Flowers $\frac{1}{3}$ in. long,

fragrant. Petals lilac, minutely pubescent. Staminal tube purple. Ovary 5-celled. Drupe $\frac{1}{2}$–$\frac{3}{4}$ in., ellipsoid-globose, 5-celled, 5- or fewer-seeded, yellow and plump when ripe.

Distribution

Commonly cultivated in India; wild in the Sub-Himalayan tract at altitudes of 2,000 to 3,000 ft.

Medicinal properties

This plant seems to have important medicinal properties which are not much appreciated in India, and are neglected in favour of the more well-known 'neem' tree (*Azadirachta indica* A. Juss.). Its use in skin diseases deserves better notice. The plant is also stated to have anthelmintic, cathartic, emetic, and emmenagogue properties. The inner bark, which is stated to contain a yellowish-white resin, is extremely bitter, nauseous, and devoid of astringency; the outer bark is very astringent.

Constituents

The fruits have been found to contain a poisonous constituent of unknown composition. There is no picrotoxin present (*5*). In the variety *australasica* DC., a toxic substance has been demonstrated, which occurs in the resinous portion extracted with ether from both the ripe and unripe fruits (*6*).

Toxicity

In certain parts of the world poisoning in man and animals, especially in hogs, due to the eating of the drupes has been reported. Watt (*7*) records a case of a girl who took some of these, became unconscious, and died. He states that six to eight drupes produce nausea, spasms, and choleraic symptoms followed by death. It is also further stated that goats and sheep are not only not affected but eat the fruit greedily. Reports have recently been received of cases of poisoning at the Ranchi Indian Mental Hospital, where some of the patients developed severe colic, pain, diarrhoea, and vomiting after eating the drupes. According to Parker (*8*), the tree is much lopped for fodder.

Watt and Breyer-Brandwijk (*9*) give the following account regarding the toxicity of the plant: "Feeding experiments by the Veterinary Research Laboratories at Onderstepoort proved negative (*10*), until Steyn (*11*) found that the seeds produce gastro-enteritis in sheep and paralysis in pigs, rabbits, and guinea-pigs. Later work by Steyn (*12*) shows that pigs are most susceptible to poisoning by the berry, while goats are somewhat less susceptible than sheep. Muscovy ducks cannot be killed even by large doses, but fowls are easily poisoned. Dogs vomit after ingestion of the berry and do not develop systemic poisoning. The symptoms which are fully described for various animals by Steyn and Rindl (*10*) are excitement, accompanied by rapid heart action, followed by paralysis, extreme cardiac weakness, cyanosis, and great respiratory embarrassment. Death is by asphyxia. Animals which survive for some time develop a foetid diarrhoea. *Post mortem*, there is cyanosis, and signs of irritation of the gastro-intestinal tract. The symptoms and

post-mortem findings are the same when an alcoholic extract of the fruit is injected subcutaneously. According to Steyn and Rindl (*10*) the bark and young flowers are less toxic than the berries, and the fresh leaves are harmless."

No specific chemical or pharmacological antidotes are known, hence the treatment can only be symptomatic (*13*). *Treatment*

3. WALSURA Roxb.

(From the Tamil name *walsura*, of *Walsura piscidia* Roxb.)

Trees. Leaves 1–5-foliolate ; leaflets usually opposite, entire. Calyx 5-fid or 5-partite, imbricate. Petals 5, free. Stamens 10 or 8 ; filaments free or connate into a tube ; anthers terminal or inserted in the notch at the apex of the filament. Disc usually annular, fleshy. Ovary short, 2–3-celled, sunk in the disc; style short; stigma turbinate-capitate, 2–3-toothed ; ovules 2 in each cell. Fruit baccate, shortly tomentose, 1- rarely 2-celled, 1–2-seeded. Seeds enclosed in a fleshy aril, exalbuminous ; cotyledons thick. *Botanical characters*

In India and the Malaya. *Distribution*

Walsura piscidia Roxb.*

Fl. Brit. Ind., I, 564.

Vernacular names: BURMA—Joeboe; GAYA—Siloi; KANARESE—Valurasi; MALAYALAM—Perillappicha; SAMBALPUR—Bakom, Kuruwan; TAMIL—Chedda-vakku, Kanji-maram, Malaivirali, Sattu-vakku, Valasura, Valsura (Walsura); TELUGU—Ettavaludu, Valarasi, Valavadini, Vallarasi, Valurasi, Valursi; URIYA—Mundika.

A small tree. Leaves 3-foliolate ; leaflets 2–3½ by ¾–1¼ in., oblong-elliptic, obtuse, sometimes retuse, glabrous, shining above, paler beneath. Flowers yellowish-white, in corymbosely branched panicles about equalling the leaves. Petals $\frac{1}{10}$ in. long, imbricate. Staminal tube half as long as the petals, hairy inside, equally 10-cleft for about two thirds of its length, the divisions 2-toothed at the apex. Stigma 2-dentate. Berry $\frac{3}{8}$–$\frac{5}{8}$ in. long, ovoid, oblong or subglobose, bright orange-yellow when ripe, finely tomentose, minutely apiculate. Seed usually solitary, completely enveloped in a white juicy aril. *Botanical characters*

Found on the Western Ghats from North Kanara to the Anamalais, Pulneys, and Travancore; also in Northern Circars, Carnatic, the Deccan, Hazaribagh, Gaya Ghats, and in the Puri Division. *Distribution*

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*Haines (*14*) and Gamble (*15*) include Roxburgh's *W. ternata* (Fl. Brit. Ind., I, 563) in this species.

Uses and properties

An oil is said to be obtained from the wood by heating the chips, and is used against itch (*14*). Corre and Lejanne state that in the Antilles the tree is known as *Herbe à mauvaise gens* (herb of evil people) or *Herbe à méchants* (herb of scoundrels), and the bark is considered as a dangerous emmenagogue and violent emetic. Roxburgh and following him many other workers state that the bark is largely employed to intoxicate fish, and that fish so caught are not less wholesome to eat than ordinary fish. The fruit of another species of the same genus is said to be the 'jauz-el-kai' or the emetic nut of the Arabs, who also use it as a hair wash to kill vermin and as an ointment to cure itch (*7*).

Constituents

The plant is stated to contain saponins (*16*).

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Family XXII.—CELASTRACEAE

(Staff-tree Family)

Botanical characters

Trees or erect or climbing shrubs, sometimes thorny. Leaves opposite or alternate, usually coriaceous, simple, never lobed; stipules caducous or 0. Flowers small, usually cymose, bisexual or polygamous. Calyx 4–5-lobed or -partite, imbricate, persistent. Petals 4–5, rarely 0, imbricate. Stamens 3–5, rarely 2 or 10, inserted under, on, or within the edge of the disc. Disc usually conspicuous, rarely 0. Ovary sessile on the disc, free or confluent with it, 2–5-celled; style short or 0; ovules usually 2 in each cell. Fruit a capsule, berry, drupe or samara. Seeds arillate, rarely exarillate, sometimes winged.

Distribution

Throughout the tropical and temperate regions.

Economic and toxic aspects

Many species belonging to this family are bitter and astringent, emetic and cathartic.

Some species of *Euonymus* are lopped for fodder, while some of them are the sources of useful timber. The bark of *E. atropurpureus* Jacq. is imported into India from the United States for medicinal purposes. It is used mainly as a cathartic in the same way as podophyllum. The root-bark contains several substances, such as citrullol, euonymol, atropurol, euonysterol, homoeuonysterol, etc., but there is no evidence of the presence of any glucosidic substance (*1*). *Kokoona zeylanica* Thw.* yields an oil which is stated to be used in Ceylon for protection against leeches. Seeds of black-oil plant (*Celastrus paniculatus* Willd.) yield two oils, one a deep-scarlet or yellow oil obtained by expression is used for burning and for external use in rheumatism; the other, an empyreumatic black oil with a peculiar strong aromatic odour obtained by the destructive distillation of the seeds, has powerful diaphoretic and stimulant properties. The latter oil is an article of some commercial importance and is regarded as useful in beriberi. The leaves of this plant, which are said to contain a nontoxic alkaloid (*2*), are believed to bring good luck if plucked before sunrise on a full-moon day, if it happens to fall on a Sunday, and are retained.

Elaeodendron glaucum Pers. is stated to possess strongly emetic properties and to be fatal in large doses.

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*In Fl. Brit. Ind., this plant is reported from Anamalais, but it is not included in Gamble's Flora of the Presidency of Madras.

Constituents

The members of this family have been found to contain : (*a*) *alkaloids*, such as cathine (d-nor-ψ-ephedrine), cathidine, and cathinine, (*b*) *saponins*, and (*c*) *essential oils*.

ELAEODENDRON Jacq. *f.*

(From the Greek *elaia*—an olive, and *dendron*—a tree; the fruit is oily and of the shape of an olive.)

Botanical characters

Small trees or shrubs. Leaves opposite or subopposite. Flowers white, green or brown, in axillary dichotomous cymes, often polygamous, 4–5-merous. Stamens inserted on and near the margin of the large often lobed disc; anthers subglobose; filaments subulate, at length recurved. Ovary conical, base confluent with the disc. Drupe dry or pulpy, usually with 1 exarillate seed.

Distribution

In tropical and subtropical regions.

Elaeodendron glaucum Pers.

Fl. Brit. Ind., I, 623, in part.

(Ceylon Tea Tree, Olive Plum)

Vernacular names: ALMORA—Loonia, Sauni; BANDA—Jamrasi, Mamri; BENGAL—Raj-jehul; BHIL—Bata-karas; BOMBAY—Aran, Bhukas, Bhutkes, Tamruj; BUNDELKHAND—Mamri; CENTRAL PROVINCES—Jamrasi, Jum, Kala-mukha, Rassi, Rohi; GARHWAL—Dhebri; GOND—Dhakka, Nisur; GUJERAT—Alan; HINDI—Jamrassi; HOSHIARPUR—Mugoo; HYDERABAD—Bhutrak, Shi; KANARESE—Kannire, Mukarive, Mukarki, Mukkarite, Tha-maroja; KOLAMI—Miri, Thanki; KONKAN—Burkas; KUMAON—Shauriya; LEPCHA—Chikyeng; MALAYALAM—Karuniraka; MARATHI—Aran, Bhuta-pala, Bilur, Burkas, Tamruj; MELGHAT—Niru; MUNDARI—Niri, Nirsin; OUDH—Chauri, Metkur; PUNJAB—Bakra, Jamoa, Marindu, Mirandu, Mirgu, Morindonu, Padriun; RAMNAGAR—Sounria; RANIKHET—Ajan; SANTALI—Neouri, Neuri, Niuri; TAMIL—Irgoli, Irkuli, Kannirai, Karrukuva, Karuvali, Kiri, Pirai, Seluppai, Siri; TELUGU—Bira, Bira-nerija-manu, Bhutan-kusamu, Bootigi, Kanemi, Kannilu, Kanniru, Nerasi, Niradi, Nirasi, Nirija; UNITED PROVINCES—Bakra, Chauli, Daberi, Dabero, Jamuva, Mamri; URIYA—Mokha, Pisitondora.

Botanical characters

A small tree. Leaves $2\frac{1}{2}$–6 by 1–$2\frac{1}{2}$ in., extremely variable, ovate or elliptic, obtuse, acute or acuminate, often twisted at the apex, crenate-serrate or subentire, usually pale-grey when dry. Flowers $\frac{1}{4}$ in. diam., in slender cymes under 3 in. long. Drupe obovoid or oblong, nearly dry, $\frac{1}{3}$–$\frac{1}{2}$ in. long, apiculate.

Distribution

Occurs throughout the hotter parts of India, ascending to an altitude of 6,000 ft. along the outer Himalayas.

Uses and properties

The handsome reddish-coloured wood of this tree is much valued, as it works well and takes a fine polish. The leaves, root, and bark are used in indigenous medicine. Watt (*3*) states that the bark is used externally to cure swellings and is said to be a violent poison if taken internally. According to Dymock (*4*), however, the bark contains 8 per cent of tannins, and there appears to be no ground whatever for

the statement that the plant is poisonous. Kirtikar and Basu (5) state that a piece of root as thick as a finger and a little longer is crushed and soaked in water by the Mundas; the solution is strained off and taken internally as an emetic. Overdoses are said to be fatal.

FIG. 51. *Elaeodendron glaucum* Pers.

Dornon, quoted by Watt and Breyer-Brandwijk (*6*), states that the natives of Rhodesia use a species of *Elaeodendron* for trial by ordeal. If the accused becomes rapidly unconscious, without vomiting, he is guilty. Its administration is frequently followed by vomiting and purging.

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Family XXIII.—RHAMNACEAE

(Buckthorn Family)

Botanical characters

Trees, or erect or climbing shrubs, usually astringent or bitter; branches frequently thorny, sometimes bearing tendrils. Leaves simple, chiefly alternate, usually coriaceous, often 3–5-nerved; stipules small, deciduous or modified into prickles. Flowers bisexual or polygamous, small, green or yellowish, in simple or panicled axillary cymes. Calyx 4–6-fid; lobes triangular, usually keeled within, valvate. Petals 4–6, small, rarely 0, inserted on the throat of the calyx-tube. Stamens 4–6, opposite the petals. Disc fleshy and filling the calyx-tube, or membranous and lining it. Ovary free or sunk in the disc, free from or adnate to the calyx-tube, 3- (rarely 2–4-) celled; style short, simple or 2–4-lobed; ovules 1 in each cell. Fruit superior or inferior, 3- (more rarely 1–4-) celled, drupaceous or capsular, the capsules sometimes winged.

Distribution

In tropical and temperate regions.

Economic and toxic aspects

Many members of this family possess bitter, astringent, diaphoretic, diuretic, cathartic or emollient properties; a few are emetic. Some plants are of economic value.

Many species of *Zizyphus*, such as the Indian jujube or 'ber' [*Z. jujuba* (Linn.) Lam.] and 'unab' (*Z. sativa* Gaertn., syn. *Z. vulgaris* Lam.), bear edible fruits, which are also noted for their emollient and pectoral properties. Their leaves are valuable as fodder for camels, goats, and sheep, while the thorny branches are often employed for making hedges. The leaves of *Z. jujuba* are considered as one of the best kinds of food for tussah silkworms. The fruit and bark of *Z. xylopyrus* Willd. have for a long time been employed for tanning by Indian tanners; if collected at the right time, the fruit may yield as much as 20 per cent, and is thus one of the cheapest sources of tannins in India. The bark of *Z. jujuba* is also rich in tannins, while its hard timber is used for making agricultural implements as well as for fuel.

The root-bark of *Ventilago madraspatana* Gaertn. produces a valuable dye which is used for dying cotton fabrics, but is also stated to be well adapted for tussah silk.

Species of *Rhamnus* are well known for the cathartic properties of their fruits and barks; some of them are valued for pigments and dyes obtained from them. Thus, in Europe, the pigment called sap green

is prepared from the ripe fruits of *R. catharticus* Linn., while the bark of this and of *R. infectoria* Linn. and *R. frangula* Linn. is the source of a yellow dye, largely used by calico printers. The most important is, however, the lokao dyestuff of China, also called the Chinese green, obtained from the barks of certain species of *Rhamnus*, especially *R. tinctoria* Waldst. & Kit., which imparts beautiful shades of green to silk fabrics. Nothing is, however, known with regard to the Indian species of this genus as sources of these or similar dyes.

The fruits of the foreign *Rhamnus catharticus* (purging buckthorn) have at first sweetish, but afterwards bitter and acrid taste ; their juice is used as a laxative in veterinary practice. Harmful effects are likely to be produced, if the plant were eaten by livestock in excess. The bark of the European *R. frangula* (alder buckthorn) is also used as a laxative ; it contains the glucoside frangulin which on hydrolysis gives rhamnose and frangula-emodin. The most important member of the family, however, is *R. purshiana* DC. of America the bark (cascara sagrada, sacred bark) of which is widely used as a mild laxative, acting principally on the large intestines ; it is especially employed in chronic constipation. Cascara sagrada contains emodin and an isomeric substance but no chrysophanic acid or chrysarobin, or glucosides yielding emodin, chrysophanic acid or rhamnetin. The active principle (or principles) producing the aperient action of the drug is soluble in water and in alcohol, but the chemical nature has not been established (*1*). The total amount of hydroxymethylanthraquinones present in the bark varies from 1·4 to 4 per cent (*2*). When cascara is administered hypodermically its constituents are rapidly absorbed and excreted by the kidneys, producing renal irritation, but not catharsis (*3*). It is generally stated that the fresh bark is emetic on account of the presence of a ferment, which gradually disappears as the bark is aged. True and Klugh (*4*), however, did not find any emetic properties in the unaged bark. Not much is known of the Indian species of *Rhamnus*. The fruits of the Indian *R. virgata* Roxb. (*R. dahuricus* Fl. Brit. Ind.) possess emetic and purgative properties ; they are bitter even when ripe. Watt (*5*) states that the fruit of the West Himalayan *R. purpurea* Edgew. is purgative, and that of another North Indian plant, *R. persica* Boiss., is sweet but affects the head when eaten in excess.

According to Pammel (*6*), some species of *Rhamnus* and *Gouania* contain saponins, which are also found in several other plants of this family. He also states that some of them are used as fish poisons and that it is not surprising that poisoning may be caused by members of this family. The brownish-black berries of coyotillo (*Karwinskia humboldtiana* Zucc.) of the South-Western United States and Mexico

are stated to be very poisonous. According to Muenscher (*7*), the pulp of these appears to be harmless, but the seed affects all domestic animals; children also have been poisoned by eating the seeds. The leaves, according to him, are also somewhat poisonous. This plant produces a paralytic condition, affecting the hind quarters of cattle. Lander (*8*), on the authority of Cornevin, states that the leaves of the foreign *Rhamnus alaternus* Linn. arrest lactation.

Constituents

Members of this family contain: (*a*) *glucosides*, such as lokain, frangulin, xanthorhamnin, etc., (*b*) *saponins*, (*c*) *alkaloids*, (*d*) *anthraquinone derivatives*, such as emodin, *iso*emodin, chrysophanic acid, oxymethylanthraquinones, etc.

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Family XXIV.—VITACEAE (Ampelidaceae)

(Vine Family)

Botanical characters

Shrubs, climbing by means of tendrils, less often erect, or small trees, rarely subherbaceous; stems and branches nodose; juice copious, watery. Leaves alternate, simple or compound, stipulate. Flowers bisexual (rarely unisexual), usually small and greenish, in compound usually leaf-opposed inflorescences; peduncles often transformed into simple or compound tendrils. Calyx small, entire or 4–5-toothed or -lobed. Petals 4–5, valvate, free or cohering, usually caducous. Stamens 4–5, opposite the petals, inserted at the base of the disc or between its lobes; anthers free or connate. Ovary usually partially sunk in the disc, 2–6-celled; ovules 1–2 in each cell. Fruit a berry, often watery, 1–6-celled; cells 1–2-seeded.

Distribution

In tropical and temperate regions.

Economic and toxic aspects

*Vitis** is the most important genus of the family. *V. vinifera* Linn. furnishes the grapes, and is cultivated in most warm countries. *V. labrusca* Linn. (fox grape) is one of the important sources of the American grapes. Grapes range in colour from green or white to deep red, purple or black, and in shape from globose to narrowly oblong. They are cultivated for the edible fruits, which are also largely used for making wines of which about 3,000 million gallons are made every year. When dried, the fruits form raisins; the sultana raisin is prepared from a seedless variety. The currants of commerce are the fruits of the Corinthian variety. The edible-stemmed vine (*Cissus quadrangularis* Linn., syn. *Vitis quadrangularis* Wall.) is largely used in indigenous medicine as an alterative, stomachic, and in irregular menstruation; the succulent quadrangular stems when young are often eaten in curries. The thick and soft stems of *Cissus repanda* Vahl (*Vitis repanda* Wight & Arn.) and *Ampelocissus latifolia* Planch. (*Vitis latifolia* Roxb.) yield a quantity of drinkable "water" which is much appreciated by travellers in Indian forests. To obtain this water, an oblique cut is made through the stem with one clean stroke of a knife, and then another through it higher up, when the water at once runs out from the lower end of the piece if held vertically. The fruits of at least two wild Indian representatives of this family, *viz.*, *Ampelocissus rugosa* Planch. (*Vitis*

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* *Vitis* as understood in the "Flora of British India" has been split up into a number of genera by Planchon in Vol. V of De-Candolle's "Monographiae Phanerogamarum" (1883).

rugosa Wall.) and *A. latifolia*, are edible; those of the former are often sold in the outer Himalayas as wild grapes.

Some members of this family possess acrid properties. Every part of *Cissus setosa* Roxb. (*Vitis setosa* Wall.) of the Western and Southern India is extremely acrid, and the juice if brought into contact with skin produces dermatitis in susceptible persons; this plant is used as local stimulant in indigenous medicine. In this connection it may be mentioned that Pammel (*1*) records the presence of toxicodendrol in *Parthenocissus tricuspidata* Planch. (*Vitis inconstans* Miq.) of Japan, which he states to be poisonous. According to Dymock (*2*), the tubers of another West and South Indian plant *Ampelocissus arnottiana* Planch. (*Vitis indica* Wight & Arn., and of Lawson in Fl. Brit. Ind., *non* Linn.), when fresh, are also acrid, but he thinks that this acridity is due to the mechanical irritation caused by the needles of oxalate of lime. According to Watt & Breyer-Brandwijk (*3*), the South African *Cissus crameriana* Schinz is poisonous, and the fruits of *Cissus hypoleuca* Harv.*, another South African plant, are strongly irritant and astringent.

REFERENCES

1. Pammel: *A Manual of Poisonous Plants*, 1911.
2. Dymock, Warden & Hooper: *Pharmacographia Indica*, 1890–93, Vols. 1–3.
3. Watt & Breyer-Brandwijk: *The Medicinal and Poisonous Plants of Southern Africa*, 1932.

*This species is mentioned by Watt & Breyer-Brandwijk with "Szysz." as the author; but it is accredited to Harvey in "Index Kewensis" and in "Flora Capensis".

Family XXV.—SAPINDACEAE

(Soap-nut Family)

Botanical characters

Trees or shrubs, rarely climbing herbs. Leaves alternate (rarely opposite), usually compound; stipules caducous or 0. Flowers usually polygamo-dioecious and small, often irregular. Calyx mostly 4–5-lobed or -sepalous; lobes or sepals often unequal, imbricate or rarely valvate. Petals 4–5 or 0, free, equal or unequal, often bearded or bearing a scale at the base within. Disc annular or unilateral, rarely wanting in the male flowers. Stamens 5–10 (usually 8), inserted inside the disc at the base of the ovary or outside or on the disc; filaments usually free, often pubescent. Ovary centric or excentric, entire, lobed or partite nearly to the base, 1–4-celled; ovules 1–2, rarely more in each cell; style simple or divided, usually terminal; stigma usually simple. Fruit capsular or indehiscent, entire or lobed, sometimes winged. Seeds generally exalbuminous, often arillate.

Distribution

Throughout the world; especially in the tropics.

Economic and toxic aspects

This family contains a number of economic plants. Several species are said to be poisonous to fish and contain saponins. Some plants yield valuable timber. Litchi (*Litchi chinensis* Sonner., syn. *Nephelium litchi* Cambess.) is cultivated for its delicious fruit; the edible portion is the sweet aril which covers the seed and the whole is enclosed in a thin, brown, rough pericarp. The fruits of the soap-nut trees (*Sapindus mukorossi* Gaertn. and *S. trifoliatus* Linn.) contain saponins and are very commonly used as detergents for washing hair and clothes, especially woollen and silk fabrics. A refreshing drink is made from the seeds of a South American plant, guarana (*Paullinia cupana* H. B. & K.); it contains caffeine, saponins, and an acrid green fixed oil (*1*). *Dodonaea viscosa* (Linn.) Jacq. is one of the commonest of hedge plants in Northern India. *Filicium decipiens* Thw. of South India, a very ornamental tree with bright-green fern-like leaves, is sometimes cultivated in gardens. Maples (*Acer*) are commonly used abroad for timber of inferior quality, but they are not much used in India. The leaves of *A. pictum* Thunb. are stated by Watt (*2*) to yield an acrid juice which blisters the hands, but this has not been substantiated. The lac produced on the 'kosumba' [*Schleichera oleosa* (Lour.) Merr., syn. *S. trijuga* Willd.] is of the most highly prized quality. Hydrocyanic acid has been reported to occur in the seeds of this plant.

Many species of *Aesculus* contain saponins in the seeds and some of them are used as fish poisons abroad. Horse chestnut (*Aesculus hippocastanum* Linn.), an exotic tree cultivated in some parts of India, contains in its bark the glucoside aesculin which is said to be a febrifuge. The nuts of this plant are saponaceous and are sometimes used to whiten linen; they are also used as food for horses. Certain species of *Aesculus* are stated by Pammel (*1*) to be gastro-intestinal irritants, while the American species have been stated to irritate the central nervous system. The more prominent symptoms produced are confusion of mind, vertigo, stupefaction, and coma. It is likely that the Indian horse chestnut (*A. indica* Colebr. *ex* Wall.) may have similar properties. Watt (*2*), however, records that in the Himalayas the fruit of this plant is "eaten greedily by cattle, and in times of scarcity by men after being steeped in water, and sometimes mixed with flour". Several species of *Paullinia* are recorded as fish and arrow poisons but none occurs in India. *Cupania pseudorhus* A. Rich., an exotic plant, has been referred to by Pammel (*1*) as a fish poison. Nothing is known of the Indian representatives of this genus. Pammel (*1*) has also recorded some of the foreign species of *Serjania* as poisonous.

The plants of this family possess bitter, tonic, astringent, also acrid, narcotic, and poisonous properties.

Constituents

Members of this family have been found to contain: (*a*) *saponins*, such as those found in *Aesculus*, *Cardiospermum*, *Cupania*, *Dodonaea*, *Harpullia*, and *Sapindus*, (*b*) *glucosides*, such as fraxin, aesculin, etc.; (*c*) *cyanogenetic compounds*, (*d*) *toxic substances*, such as those found in *Serjania*, and (*e*) *alkaloids*, such as caffeine, theobromine, etc.

KEY TO THE GENERA

A. Leaves alternate, exstipulate. Seeds exalbuminous.

- I. Stamens inserted within the disc.
  - *a*. Climbing herbs. Flowers irregular. Fruit an inflated capsule .. .. .. 1. *Cardiospermum*.
  - *b*. Trees or shrubs. Flowers regular. Disc annular.
    - *aa*. Fruit not inflated, indehiscent. Flowers small. Ovules solitary.
      - 1. Petals 0. Fruit entire, ovoid .. 6. *Schleichera*.
      - 2. Petals 4–5. Fruit of 1–3 indehiscent cocci .. .. .. 5. *Sapindus*.
    - *bb*. Fruit an inflated capsule. Flowers large. Ovules usually 2 together .. .. 3. *Harpullia*.
- II. Stamens inserted outside the disc. Fruit 3-winged .. .. 2. *Dodonaea*.

B. Leaves alternate, stipulate. Flowers irregular. Seeds albuminous .. .. 4. *Melianthus*.

1. CARDIOSPERMUM Linn.

(From the Greek *kardia*—a heart, and *sperma*—a seed; referring to the conspicuous heart-shaped spot on the seed.)

Botanical characters

Climbing herbs with wiry stems. Leaves alternate, exstipulate, biternate; leaflets coarsely dentate. Flowers irregular, in axillary racemes or corymbs, the lowest pair of pedicels developed into spiral tendrils. Sepals 4, two outer smaller. Petals 4, in unequal pairs, with 2 kinds of scales above the base. Disc unilateral, almost reduced to 2 glands opposite the lower petals. Stamens 8, excentric, sometimes connate at base, 4 shorter. Ovary 3-celled; ovules solitary; style short, trifid. Capsule membranous, trigonous, veiny, 3-celled, 3-valved, inflated, loculicidal. Seeds globose, usually arillate at the base.

Distribution

Chiefly tropical.

Cardiospermum halicacabum Linn.

Fl. Brit. Ind., I, 670.

(Balloon Vine, Black Liquorice, Blister Creeper, Heartpea, Heart-seed, Palsycurer, Pigeon's-knee, Winter Cherry)

Vernacular names: ARABIC—Habb-ul-kalkal, Taftaf; BENGAL—Lataphatkari, Nayaphatki, Noaphutki, Sibjhul; BOMBAY—Bodha, Naphat, Shibjal, Tejovati; BURMA—Ma-la-mai; GUJERATI—Karolio; KANARESE—Agni-balli, Bekkinatoddina-balli, Erum-balli, Kakara-lata, Kangu, Kangunge, Minijuballi; KHARWARI—Galphul; MALAYALAM—Jyotishmati, Katabhi, Paluruvam, Ulinna; MARATHI—Kanphuti, Kapalaphodi; PORBANDAR—Kagdolio; SANSKRIT—Jyotishmati, Jyotir, Karavi, Karnasphota, Nagna, Paravatanghi, Sakralata; TAMIL—Kottavan, Mudakattan, Mudakkottan, Periyayilai-mudakottan, Samuttiram, Samuttiradoyan, Siliyanai, Soliyan, Sugattan, Tiragamulagam; TELUGU—Budda-kakara, Ekkudu-tige, Jyotishmati-tige, Kanakaia budha-kakara, Kasari-tige, Nalla-golisyandu, Patali-tivva, Ullena-tige, Upparinta; TULU—Urundoburu.

Botanical characters

An annual, thinly pubescent or nearly glabrous herb. Leaflets much acuminate. Flowers white, $\frac{1}{8}$ in. diam. Capsule inflated, depressed-pyriform, winged at the angles. Seeds black with a white heart-shaped aril.

Distribution

Common throughout the plains of India, ascending to an altitude of 4,000 ft. in the North-Western Himalayas.

Uses and properties

The leaves and roots of this plant are used in indigenous medicine. The root is used as an emetic, laxative, stomachic, and rubefacient.

Bryant states that the leaves are irritant (*3*); in the form of a chutney they are administered in rheumatism and act as a purgative. Duthie (*4*) states that they are sometimes cooked and eaten as a vegetable.

Constituents

The plant is said to contain saponins (*5*).

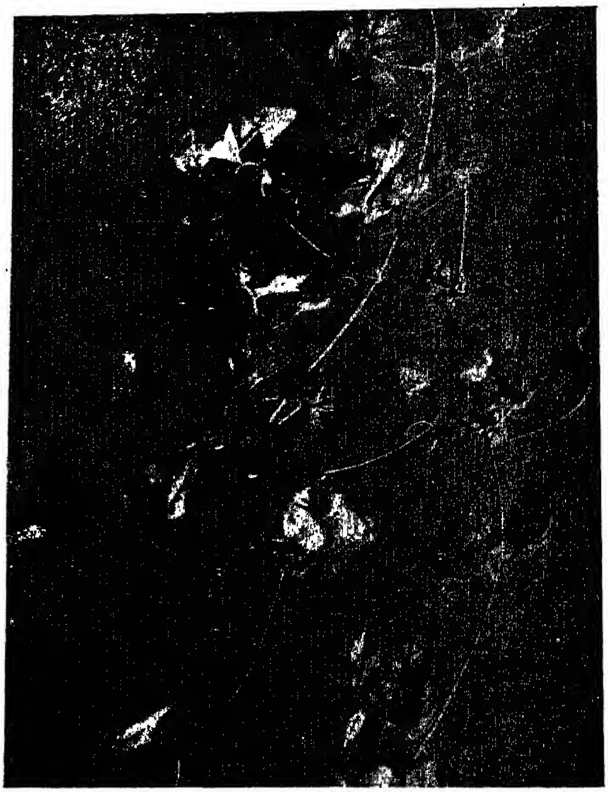

FIG. 52. *Cardiospermum halicacabum* Linn.

2. DODONAEA Linn.

(In honour of R. *Dodoens*, a Dutch herbalist of the sixteenth century.)

Botanical characters

Shrubs or small trees. Leaves alternate, exstipulate, simple or abruptly pinnate. Flowers regular, polygamous. Sepals 2–5. Petals 0. Stamens 5–10 (usually 8), inserted on the outer side of the disc where present. Ovary 2–6-angled and -celled; ovules 2, rarely 1 in each cell. Capsule membranous or coriaceous, 2–6-gonous, septicidally 2–6-valved; valves winged at the back; cells 1–2-seeded. Seeds exarillate, subglobose or lenticular.

Distribution

Chiefly in Australia.

Dodonaea viscosa (Linn.) Jacq.

Fl. Brit. Ind., I, 697.

(Dodonea, Switch Sorrel)

Vernacular names: BALUCHISTAN—Ghisanni; BOMBAY—Bandari, Bandurgi, Zakhmi; CENTRAL PROVINCES—Banderu, Kharata; HAZARA—Sanatha;

HINDI—Aliar, Mehndi, Sonalta, Valayti-mehndi; KANARESE—Bandare, Bandarike, Bandrike, Bhandaru, Bundurgi, Hangaralu, Hangaru; KANGRA—Mirandu; MARATHI—Lutchmi; MULA PASS—Anartrik; NASIRABAD—Daduni; PAB HILLS—Anartrik; PUNJAB—Ban-mendu, Mendar, Mehndru, Sanatta, Santha; PUSHTU—Ghoraskai, Ghuraskai, Vuraskai; SIMLA—Pipalu; TAMIL—Virali; TELUGU—Bandaru, Bandedu, Golla-pulleda, Pullena; URIYA—Mohara.

Botanical characters

An evergreen shrub, rarely a small tree. Leaves undivided, sub-sessile, 1–5 in. long, glabrous and viscid-shining, oblanceolate, base

FIG. 53. *Dodonaea viscosa* (Linn.) Jacq.

cuneate-attenuate. Flowers small, greenish-yellow. Capsule ½–1 in. broad, compressed; wings broad, rounded, extending from the base to the style. Seeds black.

Distribution

Met with in the North-Western Himalayas up to an altitude of 4,500 ft.; also in Sind and South India, ascending to 8,000 ft. in the

Nilgiris, where it attains the size of a small tree. It is commonly planted in Northern India as a hedge plant.

Uses and properties This plant is sometimes used in indigenous medicine as a febrifuge, sudorific, and also in the treatment of gout and rheumatism. The leaves are so dry that they are eaten by cattle only when they are very hungry. It has been reported, however, that the plant did not agree with camels as a forage plant at Thal, in the Kurrum Agency, during the Afghan campaign of 1919. According to Pammel (*1*), the plant is a fish poison.

Constituents The plant contains saponins (*6*).

3. HARPULLIA Roxb.

(From *harpulli*, the local name for *H. cupunioides* Roxb. in Chittagong.)

Botanical characters Trees. Leaves alternate, exstipulate, pinnate; leaflets alternate, entire. Flowers regular, in racemes or panicles. Sepals 4–5, erect, equal, imbricate. Petals 4–5, usually clawed, without scales. Stamens 5-8, inserted within the obscure disc. Ovary tomentose, 2-lobed, 2-celled; ovules 2 (or 1) in each cell; stigma linear, usually more or less twisted. Capsule coriaceous, inflated, 2-lobed, 2-celled, loculicidally 2-valved, cells 1–2-seeded. Seeds usually arillate.

Distribution In tropical Asia, Australia, and Madagascar.

Harpullia cupanioides Roxb.*

H. cupanoides Roxb., Fl. Brit. Ind., I, 692, in part.

Vernacular name: CHITTAGONG—Harpulli.

Botanical characters A small tree; trunk straight. Leaflets alternate to opposite, from ovate below to lanceolate above, apex considerably pointed. Panicles axillary, erect. Flowers small, pale-yellow. Petals 5. Ovary somewhat 2-lobed; style short; stigma 2-lobed, lobes reflexed; ovules one in each cell. Capsule pendulous, orbicular, 2-lobed, considerably compressed. Seed semi-oval with straight inner side; aril deep orange, covering the whole seed except the apex.

Distribution Found in the hill tracts near Chittagong.

Toxicity Pammel (*1*) records it as a fish poison, and it is said to contain saponins (*7*).

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* *H. arborea* (Blanco) Radlk. (*H. imbricata* Thw.), treated as a synonym of *H. cupanioides* in Fl. Brit. Ind., is regarded as a distinct species by later authors.

Fig. 54. *Harpullia cupanioides* Roxb.

4. MELIANTHUS Tourn. *ex* Linn.

(From the Greek *meli*—honey, and *anthus*—flower; referring to flowers which are rich in honey.)

Botanical characters

Shrubby glabrous plants with a foetid odour when bruised. Leaves alternate, stipulate, unequally pinnate; leaflets toothed, decurrent. Flowers in racemes, hermaphrodite, irregular, rich in honey, sometimes apetalous. Calyx laterally compressed, 5-partite, base with a saccate gibbosity; lobes unequal. Petals excentric, declinate, narrow, long-clawed; the fifth petal very small or wanting. Stamens 4, didynamous, declinate, inserted within the disc. Disc unilateral. Ovary 4-lobed, 4-celled; ovules 2–4 together; style deeply 4-toothed at the apex. Capsule papery, vesicular, deeply 4-lobed, 4-celled. Seeds subglobose, exarillate; albumen fleshy or horny.

Distribution

A small South African genus.

Melianthus major Linn.

Fl. Brit. Ind., I, 698.

Botanical characters

Undershrub, sometimes 10 ft. or more high. Leaflets grey, 7–11, 3–4 in. long, 2 in. wide, serrate; stipules grown together into one large intra-axillary piece, attached to the lower part of the petiole.

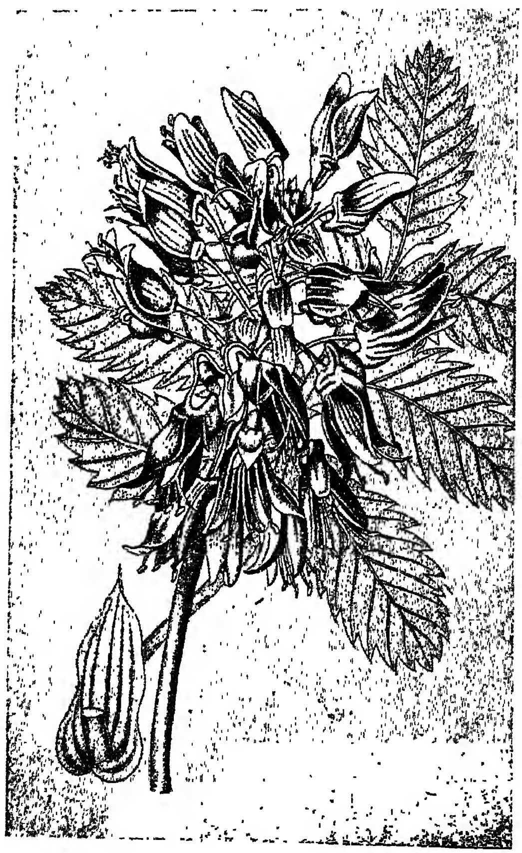

FIG. 55. *Melianthus major* Linn.

Racemes densely flowered, 1 ft. or more in length. Bracts ovate, acuminate. Flowers red-brown, 1 in. long. Capsules papery, 4-lobed at apex, 1–1¼ in. long. Seeds 2 in each cell, black and shining.

Distribution

A South African plant, which also occurs in Kumaon where it is said to have been introduced. It is cultivated in the Nilgiris and has become established at Ootacamund. In Bhutan it reaches an altitude of 9,500 ft. (Fl. Brit. Ind.).

Toxicity

No record of the properties of this plant is available in India, but in the country of its origin the root is regarded as a dangerous poison. It is medicinally used there as an emetic and also as a remedy against snake bite. Dragendorff mentions that honey obtained from this plant is poisonous (*8*). Curson (*9*) was the first to describe poisoning with this plant and reported that it produced mortality among equines and ruminants. The symptoms produced were acute diarrhoea, salivation, and colic. In one fatal case, blood-stained faeces and extreme exhaustion were observed prior to death. Steyn (*10*) has confirmed its toxicity to animals and has shown that one hundred gm of the fresh plant in the pre-flowering stage proved fatal to sheep. The symptoms appeared within three hours after administration and the animal died in about sixteen hours. There was great distress, profuse urination, oedema of the lungs, laboured breathing, and an accelerated pulse. Four hundred gm of the fresh plant produced death in a sheep within four hours. Storage does not decrease the toxicity of the plant as it was found to be toxic sixteen months after collection.

Post-mortem appearance

Post-mortem examination shows pronounced general cyanosis; injection of the subcutaneous blood vessels; marked hyperaemia and slight oedema of the lungs; hyperaemia of the liver; marked haemorrhagic swelling of the bronchial, mediastinal, retropharyngeal, and submaxillary lymph glands; numerous haemorrhages in the mucosa of abomasum; and acute catarrhal enteritis. Curson (*9*) also found marked congestion of the stomach and small intestines.

5. SAPINDUS Tourn. *ex* Linn.

(From the Latin *sapo*—soap, and *Indicus*—Indian; the fruits of several species are used in place of soap.)

Botanical characters

Trees or shrubs. Leaves alternate, paripinnate, exstipulate; leaflets entire. Flowers polygamous, regular, panicled. Sepals 4–5, 2-seriate, unequal, widely imbricate. Petals 4–5, sometimes with scales. Disc annular, lobed. Stamens normally 8, inserted within the disc; filaments usually hairy. Ovary entire or 2–4-lobed, 2–4-celled; stigma 2–4-lobed; ovules solitary; in male flowers a villous pistillode with usually 3 styles. Fruit of 1–3 fleshy or coriaceous indehiscent drupaceous cocci; pericarp saponaceous. Seeds with a very hard outer integument.

Distribution

In tropical and subtropical regions.

Economic and toxic aspects

The fruits are detersive and very acrid. In India they are well known as a substitute for soap; the pericarp is rich in saponins.

KEY TO THE SPECIES

a. Leaflets 10-16. Ovary glabrous.. .. .. 1. *S. mukorossi.*
b. Leaflets 4-6. Ovary hairy .. .. .. 2. *S. trifoliatus.*

1. Sapindus mukorossi Gaertn.

Fl. Brit. Ind., I, 683.

(Soap-nut Tree of North India)

Vernacular names: ASSAM—Haithaguti; BENGAL—Ritha; HINDI—Aritha, Dodan, Kanmar, Ritha; KUMAON—Ritha; PUNJAB—Aritha (=the fruit), Dodan (=the tree), Ritha (=the fruit), Thali; SANSKRIT—Arishta, Phenila, Urista; UNITED PROVINCES—Kanmar, Ritha; URIYA—Ita.

Botanical characters

A handsome tree. Leaves pinnate, crowded near the ends of branches; leaflets 10–16, 2–6 by $\frac{3}{5}$–$2\frac{1}{5}$ in., lanceolate-oblong, alternate or subopposite, acuminate or obtuse, glabrous, base oblique, obtuse. Panicles obsoletely tomentose. Flowers $\frac{1}{5}$ in. diam., white or purple. Petals 5, each with a woolly scale on each side at the top of the claw. Anthers small, obtuse. Ovary 3-cornered, glabrous. Fruit fleshy, yellow or pale-brown, subglobose, somewhat glaucescent, saponaceous, $\frac{3}{4}$ in. diam.

Distribution

Cultivated throughout North-West India, Bengal, and Assam; also found wild on the Himalayas up to an altitude of 4,000 ft.

Uses and properties

The saponaceous fruits are very commonly used for washing valuable fabrics, such as wool and silk, and by women for shampooing the hair. They contain fairly large amounts of saponins—10·5 per cent (*11*). The plant is described as a fish poison by Pammel (*1*).

2. Sapindus trifoliatus Linn.*

Fl. Brit. Ind., I, 682, in part.

(Soap-nut Tree of South India)

Vernacular names: ARABIC—Banduke-hindi, Finduke-hindi, Rita; BENGAL—Bara-ritha, Ritha; BERAR—Ud-rack; BURMA—Meavme-sue-khati, Miavmen-sue-khe-si; CENTRAL PROVINCES—Rithia; DECCAN—Ritha; GUJERAT—Aritha, Arithan; HINDI—Ritha (=the fruit); KANARESE—Antala, Antarale, Antavala, Arishta, Aritala, Artala, Burugu-kayi, Kugate, Kukate-kayi, Phenilu, Runde, Thalay-marathu, Tale-maradu; MALAYALAM—Arishtam, Arita, Pachakkotta, Phenilam, Pounankotta, Pulinji, Rarak, Savakkaya, Urvanji, Urvanji-kaya; MARATHI—Ringin, Rita, Ritha, Rithe: PERSIAN—Bindake-hindi, Ratah; PUNJAB—Kussam; SANSKRIT—Arishtaphalam;

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* *S. emarginatus* Vahl, with ovate-oblong or obovate-oblong, obtuse or emarginate leaflets, treated as a synonym of *S. trifoliatus* in Fl. Brit. Ind., is now regarded as a distinct species. The fruits of both are used as a substitute for soap and their properties are also similar. Furthermore, some authors consider that *S. trifoliatus* of Linnaeus, besides being an inappropriate name, refers to *Schleichera oleosa* (Lour.) Merr., and hence adopt *Sapindus laurifolius* Vahl as the name for this species.

TAMIL—Kottai-maram, Manippungu, Nittavanji, Neykottan, Ponnankottai, Pounanga, Puchikkottai, Punalai, Puvandi: TELUGU—Kunkudu, Kunkudu-kayi: URDU—Ritha: URIYA—Mukta-maya, Mukti-monju, Rentha, Rettia, Ritha.

Botanical characters

A handsome tree. Leaves abruptly pinnate; leaflets subopposite, 2–3 pairs, 3–7 by 1–4 in., lanceolate or elliptic-lanceolate, acute or acuminate. Flowers dingy-white, in terminal rusty-pubescent panicles,

FIG. 56. *Sapindus trifoliatus* Linn.

the males numerous, bisexuals few. Petals villous outside and more or less so within. Anthers apiculate. Ovary densely hairy. Fruit fleshy, 2- (usually 3-) lobed, clothed with fulvous hairs when young, glabrous and wrinkled when ripe.

Distribution

A common tree round the villages in South and West India; also cultivated in Bengal where it is a doubtful native. Occasionally planted elsewhere also.

Uses and properties

The pericarp is employed for washing purposes, in the same way as that of *S. mukorossi* Gaertn. The pericarp and the kernel of the fruit, given internally, are nauseant and expectorant and act as an emetic and purgative. According to Moodeen Sheriff, one drachm and a half to two drachms of the nut could be given as an emetic, from 20 to 40 grains as a nauseant, and from 10 to 18 grains as an expectorant.

It is further considered to be as safe an emetic as ipecacuanha. It is also stated to be used for inducing abortion (*2*). Pammel (*1*) records it as a fish poison.

The pericarp contains a fairly large quantity of saponins—11·5 per cent (*12*). According to Brannt, quoted by Watt (*2*), no saponins are contained in the stone.

6. SCHLEICHERA Willd.

(In honour of J. C. *Schleicher*, a Swiss botanist.)

Botanical characters

Trees. Leaves alternate, exstipulate, paripinnate. Flowers polygamo-dioecious, regular, fascicled on slender racemes or panicles. Calyx small, cupular; lobes 4–6, usually valvate. Petals 0. Disc annular, wavy. Stamens 5–8, exserted, inserted within the disc; filaments more or less pubescent. Ovary 3–4-celled, narrowed into a rigid style; stigma 3–4-cleft; ovules solitary. Fruit dry, crustaceo-coriaceous, indehiscent, ovoid, tipped with the style, 1–3-celled. Seeds enveloped in a fleshy aril.

Distribution

In tropical Asia and the Philippines.

Schleichera oleosa (Lour.) Merr.

S. trijuga Willd., Fl. Brit. Ind., I, 681.

(Ceylon Oak, Gum-lac Tree, Lac Tree, Honey Tree, Kusam)

Vernacular names: BOMBAY—Assumar, Gosam, Kocham, Kosam, Kosamb, Koshimb, Peduman; BHIL—Kuhumb; BURMA—Gyo, Kobin, Kyetmouk; CENTRAL PROVINCES—Kobja, Kussum; COORG—Chendala, Sandala; GOND—Komur, Pusku; GUJERAT—Kossame; HINDI—Gausam, Kasva, Kosum, Kusum; KADIR—Nityavanji, Puvam, Puvatti, Sana, Sottilai; KANARESE—Akota, Chakota, Hulimaya, Kakuta, Paparti, Sagade, Sagdi, Shargadi; KOLAMI—Baru; KONKANI—Kassimb, Kossombo; KUMAON—Kusm; MALAYALAM—Puvam; MARATHI—Kohan, Koon, Kosimb, Kusumb, Peduman; MUNDARI—Baru, Barudaru; PANCH MAHALS—Kassuma, Kocham, Koham; PUNJAB—Gausam, Jamoa, Kussam, Kussumb, Samma; SANSKRIT—Ghanaskandha, Jantupadapa, Koshamra, Krimi-vriksha, Kshudramra, Laksha-vriksha, Raktamra, Sukoshaka, Suraktaka, Vanamra; SANTAL—Baru; TAMIL—Kolama, Konji, Konjivanji, Kula, Kumbadiri, Mirugakkottai, Mudgottan, Pava, Pu, Pulachi, Pulichai, Pumarum, Puvam, Puvu, Sakkatai, Zolim-buriki; TELUGU—Busi, Kodali-pulusu, Madakà-pulusu, Mavita-vitiki, May, Mayi, Botanga, Paparti, Posuku, Pulla-kaya, Pulisari, Pulusura-marajati, Pusku, Roatanga, Sagade-posuku; TULU—Sakate; UNITED PROVINCES—Gosam; URIYA—Kusumo, Swad-kusum, Rusam.

Botanical characters

A large tree. Leaflets 2–4 pairs, 2–9 in. long, sessile or nearly so, oblong or elliptic-oblong, entire, terminal pair the largest. Racemes axillary, often several on short branchlets. Flowers yellowish-green. Fruit $\frac{3}{4}$–1 in. long, ovoid, pointed, smooth or echinate. Seeds $\frac{3}{5}$ in. long, smooth, compressed, brown.

Found in dry forests of the Sub-Himalayan tract, from the Sutlej eastwards, and throughout Central and Southern India. *Distribution*

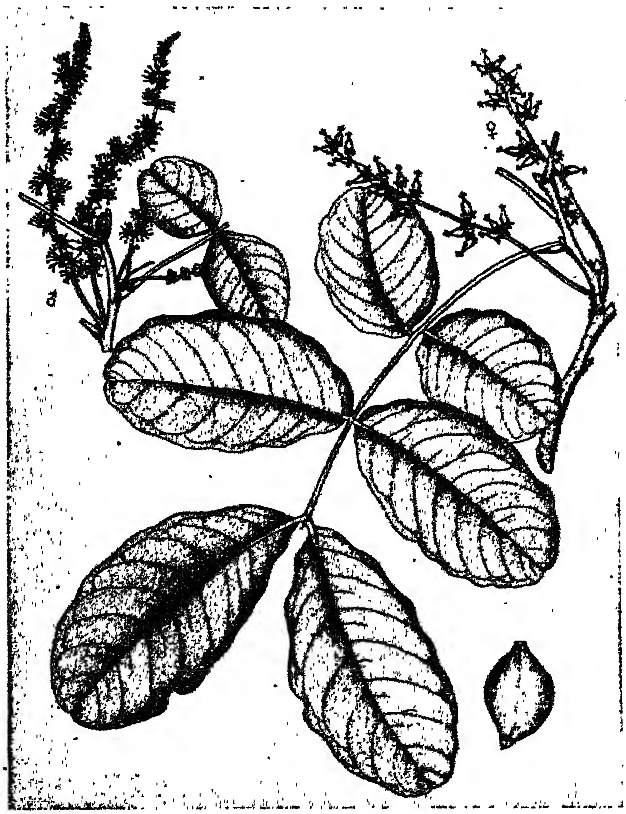

FIG. 57. *Schleichera oleosa* (Lour.) Merr.

The lac produced upon this tree is of a very high quality. The powdered seeds are applied to ulcers in animals for removing maggots. The pulpy subacid aril is edible: it has a pleasant taste and is considered to be cooling. *Uses and properties*

The seeds and their oil have been the subject of much study. The oil is used for anointing the body and as a cure for acne and itch. According to Watt (*2*), it is also used in Malabar for culinary and lighting purposes. In view of what follows the statement regarding its culinary use requires further verification. It is reputed to be the original Macassar oil, and has been reported by Bose and Sen (*13*) to be occasionally mixed, as an adulterant, with mustard oil and 'ghee' and has been known to cause symptoms of irritant poisoning. *Poisoning*

The oil is a yellowish-white clear liquid consisting of the glycerides of lauric, palmitic, arachidic, and oleic acids; it also contains small quantities of butyric and acetic acids. Hydrocyanic acid is always present in small quantities, about 0·3 per cent (*13*). The seeds do not contain hydrocyanic acid in the free state, but it is liberated on the addition of water. The cyanogenetic compound can be extracted with ether and is not glucosidic in nature (*14*). The symptoms induced by these seeds or their oil are those of irritant poisoning, producing giddiness, dilation of the pupils, and in fatal cases death from syncope presumably due to hydrocyanic acid.

Symptoms

Post-mortem appearance

Post-mortem examination shows congestion of the stomach and internal organs; the blood has a bright-red colour as in hydrocyanic-acid poisoning.

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Family XXVI.—ANACARDIACEAE

(Cashew-nut Family)

Botanical characters

Trees or shrubs, usually with acrid resinous sometimes milky juice. Leaves usually alternate, simple or compound, exstipulate, dotless. Flowers small, regular, 1-sexual, polygamous, or 2-sexual, usually panicled. Calyx 3–5-partite, sometimes accrescent. Petals 3–5, free, rarely 0. Disc flat, cupular or annular, entire or lobed, rarely obsolete. Stamens as many as the petals, rarely more, inserted under (rarely on) the disc. Ovary superior, half-inferior in *Holigarna*, 1- or 2–6-celled; styles 1–4; ovules solitary in each cell, pendulous or ascending. Fruit usually a 1–5-celled, 1–5-seeded drupe. Seeds exalbuminous.

Distribution

Chiefly tropical.

Economic and toxic aspects

This family contains a number of plants of economic interest which yield foods, drugs, oils, gums and resins, turpentine, varnish, dyes, tan, and useful timber. Mango (*Mangifera indica* Linn.) is a common fruit which is universally relished. Pistachio nut (*Pistacia vera* Linn.) is generally appreciated as an article of food and is commonly used as a dessert and in confectionery. Cashew-nut tree (*Anarcardium occidentale* Linn.) is cultivated extensively in the tropics. The fleshy receptacle (cashew apple) is eaten, while the edible kernels of the fruit form an important article of commerce. The pericarp, however, contains an irritant phenolic compound named cardol, which is black, acrid, and has vesicant properties. It is used to protect books and furniture from insects. The barks, leaves, young fruits, seeds, and oils obtained from these and other plants are believed to possess medicinal properties, and act as astringent, antidiarrhoeic, and refrigerant. The resin especially is considered to be very valuable. The ripe fruit of *Spondias pinnata* (Linn. *f.*) Kurz (*S. mangifera* Willd.), the hog plum, is sometimes eaten raw in India, but, when unripe, it is often made into a pickle or employed to impart sour taste to curries. *Pistacia lentiscus* Linn., a shrub of the Mediterranean region, yields the resin mastic largely used in the East to perfume the breath, strengthen the gums, and also to flavour wines and confectionery. Terebinth tree (*P. terebinthus* Linn.) produces red galls which are used for tanning morocco leather. *Melanorrhoea usitata* Wall. yields the celebrated black varnish of Burma. *Rhus coriaria* Linn. of Europe and the Indian *R. cotinus* Linn., the sumacs, provide a much-prized material for tanning leather. Some species of *Rhus* and the Indian *Holigarna longifolia* Buch.-Ham. *ex* Roxb.

yield a good varnish. A large number of Indian plants yield gum in certain seasons of the year. *Lannea grandis* Engl. (*Odina wodier* Roxb.) is copiously covered with its brown gum streaking down the stem ; this turns black on drying. The juice of the pericarp of the marking-nut tree (*Semecarpus anacardium* Linn. *f.*) is commonly used in India as an indelible black ink for marking linen. The juice is very corrosive and contains cardol. Irritant juices are also found in the fruits as also in the barks of some other members of this family. Travellers in Indian forests are familiar with *Rhus succedanea* Linn., *R. wallichii* Hook. *f.*, *Holigarna arnottiana* Hook. *f.*, etc. The acrid juices of these plants, when brought into contact with the skin, give rise to itching and acute burning sensation followed by inflammation—the so-called *dermatitis venenata*. The susceptibility of different persons to the irritant action of these plants varies ; some are quite immune, but others are strongly susceptible. The active principle of many of the foreign species of *Rhus* is a phenolic oily resin contained in the sticky sap which exudes when the plant is injured.

Constituents

Members of this family have been found to contain : (*a*) *toxic phenols*, such as cardol, laccol (urushiol), lobinol, anacardol, bhilawanol, etc., (*b*) *cyanogenetic compounds*, such as those found in *Corynocarpus*, (*c*) *essential oils* containing substances, such as pinene, phellandrene, limonene, camphene, dipentene, carvacrol, etc., and (*d*) *toxic resins*, such as those of *Rhus*, *Semecarpus*, etc.

KEY TO THE GENERA

A. Leaves compound (in species here described). Ovule pendulous from a basal funicle .. .. .. 3. *Rhus*.

B. Leaves simple.

I. Stamens 8–10. Fruit a reniform nut .. .. 1. *Anacardium*.

II. Stamens 5–6. Fruit a drupe.

a. Petals imbricate. Drupe superior .. .. 4. *Semecarpus*.

b. Petals valvate. Drupe inferior .. .. 2. *Holigarna*.

1. ANACARDIUM Linn.

(From the Greek *ana*—similar to, and *kardia*—a heart ; referring to the thick heart-shaped edible stalk of the cashew nut, *A. occidentale* Linn., on which the fruit is seated.)

Botanical characters

Shrubs or trees. Leaves simple. Flowers polygamous. Calyx 5-partite, erect, deciduous. Petals 5, recurved, imbricate. Stamens 8–10, all or some fertile ; filaments connate. Ovary obovoid or obcordate, 1-celled ; style excentric ; ovule 1, ascending from a lateral funicle. Fruit a reniform nut seated on a large pyriform fleshy body (hypocarp) ; pericarp cellular, full of caustic oil. Seed reniform, ascending.

Distribution

A small genus of the tropical parts of America: one species is naturalized in Asia.

Anacardium occidentale Linn.

Fl. Brit. Ind., II, 20.

(Cashew, Cashew Apple, Cashew Nut)

Vernacular names: BENGALI—Hajli-badam, Hijli-badam, Kaju; BURMESE—Sihosayesi, Thayet, Thee-noh, Thee-hot, Tihotiya-si; DECCAN—Kaju; DHARWAR—Goru-mavu; GUJERATI—Kaju; HINDI—Kaju; KANARESE—Gerabija, Geru, Gerubija, Godambe, Govamba, Gove, Jidivate, Kempu-gerubija, Turaka-geru; KONKANI—Kazu; MALAYALAM—Kappal-cherun-kuru, Kappal-sera, Kappal-mavu, Kappamava-kuru, Kashu-mavu, Parangi-mavu, Paranki-mava-kuru, Patiri-mavu, Portugi-mavu; MARATHI—Kaju; SANSKRIT—Agnikrita, Arushkara, Guchhapushpa, Kajutaka, Parvati, Prithagabija, Shobhahara, Sophara, Srindhapitaphala, Upapushpika, Vrittapatra; TAMIL—Andima, Kallarma, Kottai, Mundiri, Mundiri-kottai, Saram, Sigidima, Tirigai, Uttumabalam; TELUGU—Jeedipappu, Jeedipuandu (fruit), Jidianti, Jidimamidi-vittu, Mokkamamidi, Montamamidi-vittu; TULU—Gonkuda; URIYA—Bajan, Bhollia-ambo, Hijila-bodamo, Lanka-ambo, Lonka-bhollia.

Botanical characters

A small tree; trunk short, crooked. Leaves 4–8 by 3–5 in., hard, obovate or obovate-oblong; apex obtuse, retuse or rounded. Flowers $\frac{1}{3}$ in. diam., yellow with pink stripes. Stamens usually 9, all fertile, one larger than the rest. Fruit reniform, 1 in. long, seated on a pyriform fleshy receptacle which enlarges up to 2–3 in. long as it matures.

Distribution

Originally introduced from South America, it is now established in the coastal districts of India, especially in Chittagong, the Andaman Islands, and in South India.

Uses and properties

The cashew apple is the hypocarp formed of the enlarged pedicel and torus—and probably not of either the accrescent disc (Fl. Brit. Ind., etc.) or the enlarged calyx-base (Brandis) in addition to the torus. When fully ripe it is pleasant to eat, but very astringent when immature. The more important part of the plant is the nut within which lies the seed, the cashew nut. This is usually eaten after roasting; the fumes arising from the roasting nuts are very irritating. The kernels, when pressed, yield a light-yellow fixed oil to the extent of about 40 per cent. This oil is nutritious and emollient, and is said to be equal to almond oil in these respects.

The tar from the bark has been recommended for use against leprosy, ringworm, and corns; it is, however, powerfully rubefacient and vesicant and should be used with caution. It is also in demand as an indelible ink.

Constituents

The cellular pericarp is full of a black, caustic, oily juice which is a powerful rubefacient and vesicant. It contains the phenolic compound

cardol, anacardic acid, and an ether-soluble substance to which the cantharidine-like effects of the oil are attributed (*1*). The properties of the juice are similar to those of the marking-nut (*Semecarpus*

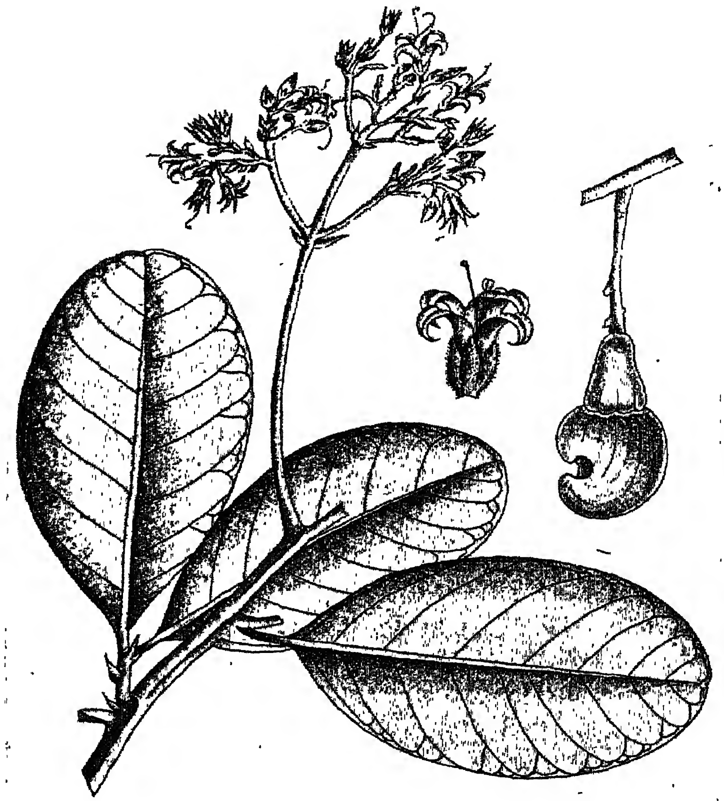

FIG. 58. *Anacardium occidentale* Linn.

anacardium Linn. *f.*) juice. Its alcoholic solution, however, on treatment with potassium hydrate turns reddish brown and not bright green, as is the case with the alcoholic solution of the marking-nut juice (*2*).

The acrid juice is seldom, if ever, used in India for criminal purposes, but instances are known where people have bitten into the fruit to get at the kernel, resulting in painful blisters on their lips. The juice is used for protecting timber, books, etc., from white ants. Its medicinal uses are the same as those of the tar from the bark. In the Andamans, it is used to colour and preserve fishing lines. In Europe (*3*), dock workers employed in unloading vanilla pods, which are painted

with an extract of this plant, are subject to a skin condition known as "vanilla itch"; this is probably produced by irritation from cardol.

According to Basiner (*4*), subcutaneous injections of small doses of cardol produce, in cold-blooded animals, paresis followed by paralysis of the extremities, stupor, paralysis of respiration, and tetanic spasms. In warm-blooded animals large doses are often not lethal, but stupor, paralysis of the extremities and diarrhoea are produced, and if death occurs congestion of the intestinal mucous membrane is present. Cardol seems to be excreted chiefly in the urine and partially also in the faeces. Applied to the skin on a small piece of lint, it raises a blister in 14 hours. *Symptoms*

2. HOLIGARNA Buch.-Ham. *ex* Roxb.

(From *hulgeri*, its local name in the Deccan.)

Lofty trees. Leaves simple; petiole with 2 or 4 spur-like deciduous appendages. Flowers crowded, in racemes or panicles, polygamous. Calyx superior; teeth 5. Petals 5, densely villous inside, persistent, valvate. Stamens 5. Ovary in the male flowers 0, in the females inferior, 1-celled; styles 3, rarely 5; ovule pendulous from near the top of the cell. Drupe inferior, partly or wholly enclosed in the hypocarp, subcompressed, oblong or ovoid, resinous, acrid; stone coriaceous. *Botanical characters*

India. *Distribution*

The juice, in most of the species, is vesicant, although it is not always equally powerful. *Toxic aspects*

KEY TO THE SPECIES

A. Leaves quite glabrous beneath.
- *a*. Leaves decurrent on the petiole .. .. 1. *H. arnottiana*.
- *b*. Leaves hardly decurrent on the petiole .. 3. *H. longifolia*.

B. Leaves ferrugineo-pubescent beneath .. .. 2. *H. grahamii*.

1. Holigarna arnottiana Hook. *f.*

Fl. Brit. Ind., II, 36.

Vernacular names: BOMBAY—Bibu, Hulgeri; KANARESE—Holageru, Holigar, Hulgeri, Kadugeru, Kagira, Katugeri, Kuttegeru; MALAYALAM—Chera, Cheru, Kattu-chera; MARATHI—Holgeri, Sudrabilo; TAMIL—Karunjarai, Kattu-cheram, Kattu-cheru; TULU—Chaire.

A tall tree; branches densely leafy at the apex. Leaves 6–12 by 2–4 in., obovate or oblanceolate, decurrent on the petiole, glabrous; petiole with 2 early deciduous spurs or tubercles at top. Flowers minute, crowded, in rufous-tomentose panicles shorter or longer than the leaves. Drupes up to 1 in. long, obliquely ovoid, rounded at the top, quite glabrous, long-pedicelled, almost entirely included in the hypocarp. *Botanical characters*

Distribution

Found in the evergreen forests of the Western Ghats from the Konkan southwards.

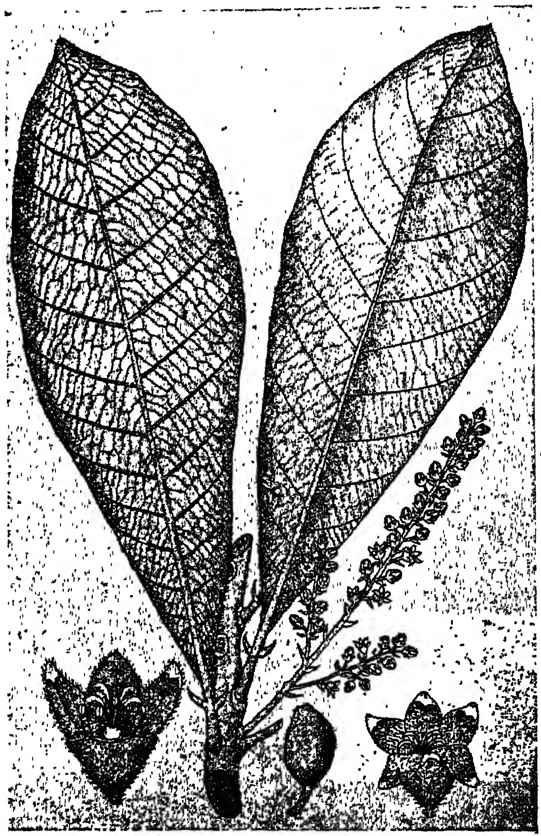

FIG. 59. *Holigarna arnottiana* Hook. *f.*

Toxicity

This tree contains large quantities of a very acrid black juice (oleoresin) which oozes out from a cut made into any part of the plant, *e.g.*, bark, branches, and fruit-rind. This juice is vesicant and is dreaded by the local people. It would appear that some people are more susceptible to it than others. This may be due either to the action of the juice being different on different people or the juice from all trees being not equally vesicant. At any rate, it is a fact that in some people blisters are produced while in others nothing happens. A sample of the dried inner bark, covered with the black juice, was examined by the authors, but no substance could be isolated to explain its irritant properties.

2. Holigarna grahamii (Wight) Hook. *f.*

Fl. Brit. Ind., II, 37.

Vernacular names: MARATHI—Balvuli, Bipte.

Botanical characters

A tree 20–30 ft. high. Leaves 12–16 by 4–6 in., rigidly coriaceous, oblanceolate, triangular above the middle, acute or acuminate, ferrugineo-pubescent beneath, base cuneate; petiole $\frac{1}{2}$–$\frac{5}{8}$ in. long, stout; petiolar spurs 2 or 4, persistent. Male panicles about 1 ft. long, female shorter. Drupes about $\frac{4}{5}$ in. long, enclosed in the cup-shaped hypocarp except $\frac{1}{6}$ or $\frac{1}{4}$ of the upper part.

Distribution

Found in Peninsular India in the western area.

Toxicity

The trunk and fruit-rind yield a black viscid juice similar in properties to that obtained from *H. arnottiana* Hook. *f.*

3. Holigarna longifolia Buch.-Ham. *ex* Roxb.

Fl. Brit. Ind., II, 37.

Vernacular names: BENGAL—Barola; BOMBAY—Halugiri, Hulagiri; BURMA—She-che; KANARESE—Holeger, Kutugeri; MARATHI—Sudra-bibo.

Botanical characters

A tall tree; bark ash-coloured. Leaves 1–2 ft. long, very narrowly cuneate-oblanceolate, acuminate, membranous, glabrous and glaucous beneath, ciliate when young, gradually narrowed from above the middle to the base which is hardly decurrent on the very short and thick petiole; petiolar spurs 2 or 4. Panicles very large and spreading, the male ones finely pubescent, females tomentose. Flowers dull-white, rusty-tomentose, $\frac{1}{10}$ in. across. Drupe entirely enclosed in the hypocarp.

Distribution

Found in Eastern Bengal, especially in Chittagong.

Uses and properties

A resinous, highly acrid and poisonous juice is obtained from the trunk and fruit-rind, which on drying forms the well-known black lacquer varnish. The secretion is of a powerfully caustic nature and blisters the skin.

Morten, quoted by Watt (*5*), states that the fruit and bark are used medicinally, but must be prescribed with caution, as they are apt to give rise to dangerous symptoms. No further information is, however, available.

3. RHUS (Tourn.) Linn.

(From the Greek *rhous*—the classical name of *R. cotinus* Linn.)

Botanical characters

Trees or shrubs. Leaves simple, trifoliate or pinnate. Flowers polygamous, in terminal or axillary panicles. Calyx 4–6-partite,

persistent. Petals 4–6, imbricate. Stamens 4–6 or 10. Ovary 1-celled; ovule pendulous from a basal funicle; styles 3, free or connate. Drupe small, dry, compressed; stone coriaceous, crustaceous or bony.

Distribution

Chiefly in subtropical and warm temperate regions.

Economic and toxic aspects

Most of the members of this genus are poisonous and have a very acrid juice: all are highly astringent and are used for tanning purposes. The acrid juices of most of these plants, if brought into contact with the skin, give rise to itching, acute burning and inflammation, producing the so-called *dermatitis venenata* of susceptible skins.

Sollmann (*6*) writing about some of the foreign species of *Rhus* says: "Contact with certain species of Rhus, common along roadsides, on fences, in woods and swamps, etc., produces typical dermatitis . . . passing through the successive stages of hyperemia and itching to violent vesication, edema, and suppuration, according to the specific sensibility of the individual; many persons are practically immune, although a sufficient quantity of the isolated toxicodendrol has never failed to produce the dermatitis.

"The active ingredient of all the species is a phenolic oily resin, *toxicodendrol*, contained in the sticky sap of the plants, which exudes when the plant is injured. It is identical or very similar in all the toxic Rhus species . . . . . It is so highly active that 1/1,000 mg has caused severe vesication . . . . . Toxicodendrol is not volatile, but it may be conveyed to some distance on the soot in the smoke of burning plants, and perhaps on dust . . ., and by insects alighting on injured plants. None is present in the pollen . . ., as had been claimed. It may be conveyed by the hands or clothing from one person to another, as if it were contagious".

The more important toxic species are: Poison sumac (*R. venenata* DC.), which is the most potent, poison oak or poison ivy (*R. toxicodendron* Linn., syn. *R. radicans* Linn. and *R. diversiloba* Torr. & Gray), *R. pumila* Michx.—all three occur commonly in North America—, and the Japanese lacquer tree (*R. vernicifera* DC.).

Travellers in the Himalayan forests often hear some of the villagers having almost similar beliefs regarding the Indian species of *Rhus*. They would not touch the rhus trees or have anything to do with them; some of them actually avoid even passing under them. Even the smoke, smell or sight, they say, will cause swelling and vesication of the skin. It is not improbable, therefore, that the Indian species have the same or identical active principle as the foreign species.

The toxic components of *R. toxicodendron*, which have been examined, are of the cardol type. "Cardol vesicans", which is the most powerful, combines to some extent the action of cantharidin and capsaicin, while "cardol pruriens" has an irritating action. These compounds are red liquids, dissolving in sulphuric acid with a blue colour (*7*). *Constituents*

After contact the exposed part may be washed freely with some alkaline solution. A 5 per cent solution of ferric chloride or ordinary soap solution are best suited for the purpose. Before exposure, use of this measure may prevent manifestation of the harmful effects. *Treatment*

Local application of baking soda or Epsom salts, 1 or 2 teaspoonfuls to a cup of water, or a 5 per cent solution of potassium permanganate may relieve the pain caused by inflammation. Fluid extract of Grindelia, diluted with 6 to 10 parts of water, is recommended for preventing the spread of inflammation. Ointments containing fatty or oily substances should not be used as the poison is soluble in oils and will, therefore, spread over other parts; such emollients may, however, be applied as a soothing agent, after the poison has been thoroughly washed away.

It has been found by experiment that a certain amount of tolerance to the toxic effects of this plant may be developed in man by giving *per os* small and increasing doses of its tincture to susceptible persons. Attacks of dermatitis in man caused by rhus may be prevented by subcutaneous injection of an alcoholic extract of the plant. The "immunity" produced by this method, however, does not persist longer than one month (*8*). *Immunity*

KEY TO THE SPECIES

A. Leaflets pubescent or tomentose beneath.
- I. Panicles terminal .. .. .. 2. *R. punjabensis*.
- II. Panicles axillary.
  - *a*. Petiole tomentose .. .. .. 4. *R. wallichii*.
  - *b*. Petiole glabrous .. .. .. 1. *R. insignis*.

B. Leaflets glabrous beneath .. .. .. 3. *R. succedanea*.

1. Rhus insignis Hook. *f.*

Fl. Brit. Ind., II, 11.

Vernacular names: Lepcha—Serh; Nepal—Kag-phulai, Khag-balayo.

A small beautiful tree. Leaves odd-pinnate, 12–18 in.; petiole glabrous, not winged; leaflets 3–4 pairs, petiolulate, 6–9 by 3–4½ in., *Botanical characters*

entire, elliptic or oblong, abruptly acuminate, glabrous above, softly tomentose beneath. Fruiting panicles axillary, 10 in. long-peduncled, branches spreading. Drupes scattered on the panicle, pedicelled, globose, $\frac{1}{3}$ in. diam.; epicarp thin, dry, bursting irregularly and enclosing a globose white mass of wax containing a very small crustaceous stone.

Distribution — Found in the inner valleys of the Sikkim Himalayas at altitudes of 3,000 to 6,000 ft., and in the Khasia Hills at 4,000 ft.

Toxicity — The juice of this species is a powerful vesicant.

2. **Rhus punjabensis** J. L. Stew. *ex* Brand.

Fl. Brit. Ind., II, 10.

Vernacular names: PUNJAB—Arkhar, Choklu, Dor, Kakkrcin, Kangar, Palai, Rashtu, Tetar, Titari.

Botanical characters — A small or medium-sized tree. Leaves odd-pinnate, 12–18 in.; rachis tomentose, not winged; leaflets 4–7 pairs, sessile or nearly so, $2\frac{1}{2}$–5 in. long, ovate-oblong or lanceolate, acuminate, entire or with a few irregular teeth, pubescent or sometimes tomentose beneath. Flowers $\frac{1}{10}$ in. across, pale yellowish-green or white, in pyramidal, terminal panicles about half the length of leaves; pedicels $\frac{1}{20}$ in. long; anthers purple. Drupe $\frac{1}{5}$ in. diam., compressed, crimson, tomentose; pericarp indehiscent.

Distribution — Found in the North-Western Himalayas at altitudes of 2,500 to 8,000 ft. from the Indus eastwards; common in the inner ranges in moist ravines, etc.

Toxicity — The juice of this tree is corrosive and vesicant. For this reason it is not cut or hacked wantonly.

3. **Rhus succedanea** Linn.

Fl. Brit. Ind., II, 12.

Vernacular names: BENGAL—Kakra-sringi; HINDI—Kakar-sing, Kakra-singi; KANARESE—Karkataka-shringi; KHASIA—Dingkain; KUNAWAR—Shah; LEPCHA—Serh-nyok; NEPAL—Ranivalai; PUNJAB—Arkhar, Arkhol, Choklu, Hala, Halai, Holashi, Hula-shing, Kakkrim, Kakrin, Lakhar, Rikhul, Tatri, Titar, Titri; SANSKRIT—Karkata-sringi; TAMIL—Karkkadaga-chingi; TELUGU—Karkkara-sringi; UNITED PROVINCES—Arkhol.

Botanical characters — A medium-sized tree. Leaves odd-pinnate, 12–24 in.; rachis glabrous; leaflets 3–7 pairs, $2\frac{1}{2}$–6 in. long, ovate-oblong or lanceolate, long-acuminate, entire, glabrous or nearly so, usually oblique; petiolule $\frac{1}{5}$–$\frac{2}{5}$ in. Flower $\frac{1}{7}$ in. across, greenish-yellow, in slender, drooping,

axillary panicles half as long as the leaves; pedicels $\frac{1}{10}$–$\frac{1}{5}$ in. long. Drupes nearly $\frac{1}{3}$ in. diam., compressed, glabrous, shining; epicarp dehiscing irregularly; mesocarp fibrous, waxy.—The form described is the var. *himalaica* of Fl. Brit. Ind.

Distribution

Found in the temperate Himalayas from Kashmir to Sikkim and Bhutan at altitudes of 3,000 to 8,000 ft.; also in the Khasia Hills between 2,000 and 6,000 ft., and in Sind.

Uses and properties

It has been stated that in Japan the stem of this tree as well as that of *R. vernicifera* DC. (the Japanese varnish tree) is incised and the exudation collected for the manufacture of the varnish used in Japanese lacquer-work. This practice, if at all present, is very uncommon in India.

The milky juice of the tree is very acrid and possesses vesicant properties. The fruit is eaten by bears (*5*).

Constituents

The leaves contain about 20 per cent of tannin. The milky juice of the tree probably yields Indo-China lac similar to the Japan lac with laccol, a toxic phenol. Laccol is identical with urushiol, also found in the foreign plants *R. vernicifera* DC. (*9*) and *R. toxicodendron* Linn. (*10*).

4. Rhus wallichii Hook. *f.*

Fl. Brit. Ind., II, 11.

Vernacular names: GARHWAL—Konki; JAUNSAR—Archoi, Arkhoi; NEPAL—Bhalaio, Chosi; PUNJAB—Arkhar, Arkhol, Arkol, Gadambal, Harku, Hulasa, Kambal, Lohasa, Rikhali, Rikhul, Urkur; UNITED PROVINCES—Akoria, Bhaliun, Kaunki, Kaunui.

Botanical characters

A small tree. Leaves odd-pinnate, 12–18 in.; petiole tomentose, not winged; leaflets 3–5 pairs, subsessile, 6–9 by 2–3 in., entire, elliptic or oblong, acuminate, pubescent or glabrous above, softly tomentose beneath. Panicles axillary, much shorter than the leaves; branches short, stout. Flowers subsessile, $\frac{1}{10}$ in. diam. Petals green-yellow with dark veins. Drupes densely crowded, $\frac{1}{3}$ in. diam., globose, puberulous; epicarp dry, crustaceous, bursting irregularly; stone bony, surrounded by wax.

Distribution

Found in the temperate Himalayas from Garhwal to Nepal, occurring at altitudes of 5,000 to 8,000 ft.

Toxicity

This plant is closely allied to the Japanese *R. vernicifera* (*see* above). Its juice is very corrosive and possesses vesicant properties.

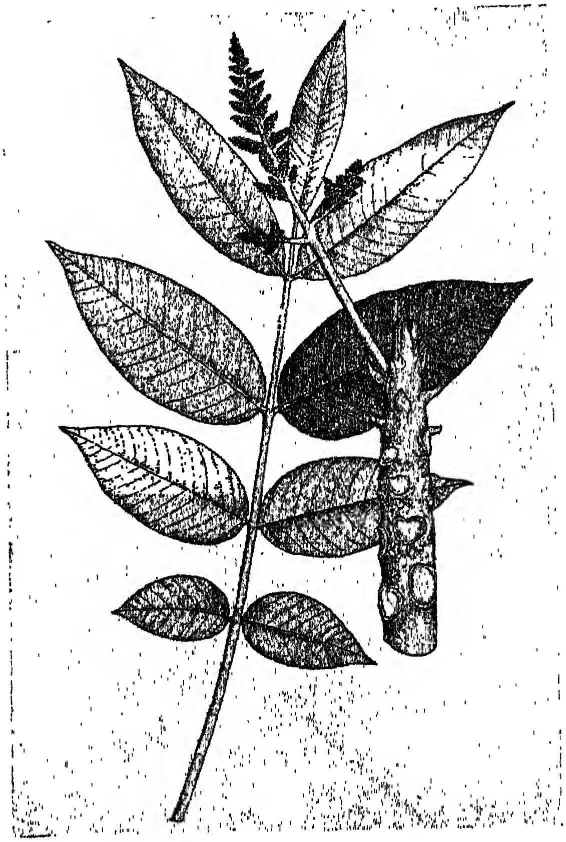

FIG. 60. *Rhus wallichii* Hook. *f.*

4. SEMECARPUS Linn. *f.*

(From the Greek *semeion*—a mark, and *karpos*—a fruit; referring to the juice of the fruit used for marking linen.)

Botanical characters

Trees. Leaves simple. Flowers small, polygamous or dioecious. Calyx 5–6-fid; segments deciduous. Petals 5–6, imbricate. Stamens 5–6, imperfect in female flowers. Ovary 1-celled; styles 3; ovule pendulous from a subapical lateral funicle. Drupe firm or fleshy, oblong or subglobose, oblique, seated on a fleshy receptacle (hypocarp); pericarp charged with acrid resin.

Distribution

In tropical Asia and Australia.

KEY TO THE SPECIES

a. Leaves more or less pubescent beneath. Panicles pubescent	1. *S. anacardium.*
b. Leaves glabrous on both surfaces. Panicles glabrous ..	2. *S. travancoricus.*

1. Semecarpus anacardium Linn. *f.*

Fl. Brit. Ind., II, 30.

(Marking-nut Tree)

Vernacular names: ARABIC—Beladin, Dahnule-faham, Habbul-fahm, Hab-el-kalab, Hab-el-kalb; ASSAM—Bholaguti; BENGAL—Bhela, Bhelatuki, Velama; BOMBAY—Bhiba, Bhilama, Biba, Bilambi; BURMA—Che, Chyai-beng, Chay-beng, Khi-si; CENTRAL PROVINCES—Bhallia, Bhilawa, Koka; DECCAN—Belatak, Bhilavan; GARO—Bawarae; GOND—Biba, Kohka; GUJERATI—Bhilamu; HINDI—Belatak, Bhela, Bhelwa, Bheyla, Bhilawa, Bilaran; KADIR—Ghambiri; KANARESE—Agni-mukhi, Bhallataka, Ger, Geru, Gerubija, Gerkayi, Gheru, Goddu-geru, Kari-gheru, Keru, Kerubija, Oorgero; KOLAMI—Loso; KUMAON—Bhilao, Bhilawa; LANSDOWNE—Bhalao; LEPCHA—Kongki, Sukung; MALAYALAM—Chera, Cherkkuru, Cherkkotta, Kampira, Temprakku, Thenkotta, Shembiri; MARATHI—Biba, Bihba, Bibu, Bibwa; NEPAL—Bhalai, Bhalaiyo, Kalo-bhalayo; PERSIAN—Biladur, Yala-dara; PUNJAB—Bhela, Bhiladar, Bhilan, Bhilawa; RANIKHET—Bhalao; SANSKRIT—Arushkara, Bhallataka, Bhallatamu; SANTAL—Soso; TAMIL—Krimugi, Kalagam, Kavaga, Pallam, Pallikkai, Pudanashanam, Se, Seran, Shaing, Shayrang, Shenkottai, Sherankottai, Sinduram, Sombalam, Tagilima, Tembarai, Vingi, Virasagi; TELUGU—Bhallataki, Bhallatamu, Gudova, Jidi, Jiri, Nalla-jidi, Nolla-jedi, Tummeda-mamidi; TULU—Gerkayi, Tere; UNITED PROVINCES—Bhala, Bhalian, Bhela, Bhilama; URDU—Bhilanvana; URIYA—Bhallia, Bhollatoki, Bhollia.

Botanical characters

A moderate-sized tree, exuding dark acrid juice. Leaves 7–24 by 4–12 in., crowded at the ends of branches, obovate-oblong, rounded at apex, sometimes shortly auricled at base, more or less pubescent beneath. Flowers $\frac{1}{5}$–$\frac{1}{3}$ in. across, greenish-yellow, in fascicles arranged in large pubescent terminal panicles. Petals 5. Ovary densely pilose. Drupe 1 in. long, obliquely ovoid or oblong, smooth, shining, black when ripe; hypocarp orange when ripe.

Distribution

Found in the Sub-Himalayan tract from the Beas eastwards, ascending in the outer hills up to 3,500 ft., Assam, Khasia Hills, Chittagong, Central India, Gujerat, Konkan, Southern Mahratta Country, Kanara and in the deciduous forests of all districts in the Madras Presidency.

Uses and properties

The wood of this tree is not used, as the black caustic juice which exudes from the bark, when it is felled, produces blisters.

The fleshy orange cup or hypocarp is eaten when quite ripe, but is slightly astringent. The pericarp, however, contains an acrid, bitter, highly astringent juice to the extent of about 32 per cent. It is brown and oily when fresh, turning black on exposure to the air, and is universally used all over India as a marking ink. It is also one of the ingredients of the preparation used by mahouts for 'chobing' elephants' feet. It is used in indigenous medicine both externally and internally, and, according to Dymock (*11*), its action appears to resemble closely that of cashew nut (*Anacardium occidentale* Linn.).

Applied externally the juice is a powerful counterirritant and vesicant, and is used by malingerers for producing ophthalmia and skin

lesions, as also by others for imitating bruises in support of a false charge. Applied locally, it has been used for procuring criminal

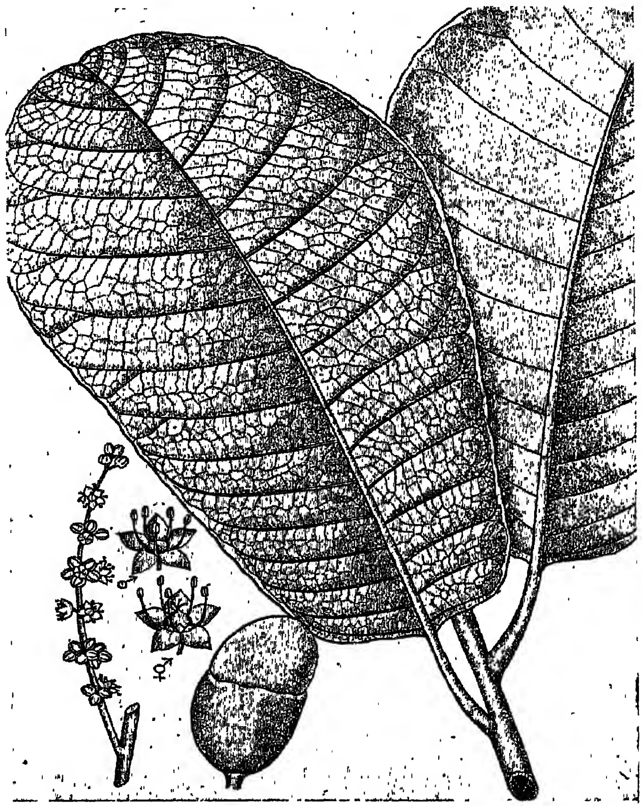

FIG. 61. *Semecarpus anacardium* Linn. *f.*

abortion. A case is known in which the juice was thrown on the person of an individual to produce injury in the same way as vitriol in Europe. In fact, it has been used for a variety of purposes where the use of an acrid and vesicant principle is desired. A case is recorded where a man introduced three marking nuts into his wife's vagina, apparently as a punishment for infidelity (*2*).

Basiner (*4*) found that within 12 hours the brown oil of the nut raised a black blister; this should not be touched as the fluid causes eczematous vesicles on any part of the body with which it may come in contact. He also observed that, as a sequel to the external applica-

tion of the oil, micturition became painful, the urine was reddish brown and bloody, and the passing of stools very painful.

Internally administered, the juice is irritant. According to Dymock (*11*), the juice of one nut mixed with a quarter of a seer of milk is the usual dose in indigenous practice, and Mohammedan writers speak of 12 to 24 grains of the juice given in oil or melted butter as a therapeutic dose, and 96 grains as a poisonous dose. It is very rarely, if ever, given in India internally as a poison.

Constituents

Very little systematic work was done with regard to the chemical composition of this drug until recent years. It was suggested by earlier investigators that the black corrosive juice of the pericarp contained a tarry oil consisting of 90 per cent of an oxy-acid named anacardic acid, and 10 per cent of a higher nonvolatile alcohol called cardol. Naidu (*12*) isolated catechol and a mono-hydroxy phenol which he called " anacardol " besides two phenolic acids and a fixed oil from the kernel of the nut. Recently, Pillay and Siddiqui (*13*) have studied the composition of the drug. They were unable to find either anacardic acid or cardol or catechol and anacardol, as reported by previous investigators. They, however, succeeded in isolating the following constituents from the juice of the pericarp: (*a*) A mono-hydroxy phenol which forms 0·1 per cent of the extract; this is named " semecarpol "; (*b*) an o-dihydroxy compound forming about 46 per cent of the extract (about 15 per cent of the nut); this has been called " bhilawanol "; and (*c*) a tarry, nonvolatile corrosive residue forming about 18 per cent of the nut. No work has, however, been done to determine the action of the active principles occurring in the drug.

2. Semecarpus travancoricus Bedd.

S. travancorica Bedd., Fl. Brit. Ind., II, 31.

Vernacular names: MALAYALAM—Avukaram; TAMIL—Kattu-shenkottai; TELUGU—Natu-sengote.

Botanical characters

A very large tree; bark grey, black-blotched. Leaves 12 by 5–6 in., oblong or obovate-oblong, tip rounded, base rounded or acute, glabrous on both surfaces, very coriaceous; petiole 2 in. Panicles glabrous. Flowers 5–6-merous. Drupe 1 in., obliquely oblong, black; hypocarp broad, short, furrowed.

Distribution

Found in the evergreen forests of Tinnevelly and Travancore up to an altitude of 4,000 ft.

Properties

It yields a caustic black juice similar to that of *S. anacardium* Linn. *f.*

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Family XXVII.— CORIARIACEAE

(Coriaria or Tanner's-tree Family)

Botanical characters

Glabrous shrubs, rarely annuals, twigs angular. Leaves opposite or ternate, simple, exstipulate. Flowers small, green, bisexual or polygamous, in axillary racemes. Sepals 5, imbricate, persistent. Petals 5, smaller than the sepals, fleshy, keeled within, thickened and enlarged after flowering and embracing the fruit. Stamens 10, free or the alternate adnate to the petals. Disc 0. Carpels 5 or 10, free, 1-celled, 1-ovuled, whorled on a fleshy receptacle. Fruit of 5 or 10 oblong compressed, dry nuts, closely embraced by the fleshy petals.

Distribution

The Mediterranean region, the Himalayas, Japan, New Zealand, and the Andes.

Economic and toxic aspects

This family contains only one genus, *Coriaria*, many species of which are poisonous. The leaves and bark of the Mediterranean plant, the currier's-sumac or *redoul* of French gardens (*Coriaria myrtifolia* Linn.), contain large quantities of tannin which is used for dyeing purposes. The leaves of this plant were at one time extensively used to adulterate senna (*1*). Both the leaves and the berries have been reported to produce symptoms of poisoning (*2*). Much has been written about the poisonous properties of the New Zealand representatives; these are highly toxic to animals that have not developed tolerance by eating small quantities of these plants (*3*). The pulp of the fruit of toot-poison (*C. ruscifolia* Linn.) of New Zealand is used by the local inhabitants in the preparation of an intoxicating beverage (*1*). *C. ruscifolia* contains a toxic oil and a crystalline nonnitrogenous glucoside, tutin (*4*), very nearly allied to the glucoside coriamyrtin isolated from *C. myrtifolia*. According to Blyth (*3*), coriamyrtin and tutin belong pharmacologically to the picrotoxin group of substances, tutin being somewhat less toxic than coriamyrtin. There is first depression, followed by salivation; the pulse becomes slow, respiration increases in frequency, and finally clonic convulsions occur. A kitten weighing 1 kgm was killed by a dose of 129 mgm in 40 minutes; 1 mgm induced in a cat, weighing 2 kgm, a convulsive seizure, and the animal did not recover for twenty-four hours. Ford (*5*) found that tutin combines with nerve tissues, thereby losing its toxicity; no tolerance is acquired. Coriamyrtin reduces temperature (*6*), and is a poison producing painful convulsions; it causes contraction of the pupils and finally asphyxia (*7*). Its action is more prompt but shorter in duration than that of picrotoxin (*8*).

Tutin produces an increased secretion of saliva, a decrease in the frequency of the pulse, an increase in the respiratory rate, and convulsions (*9*).

CORIARIA Niss. *ex* Linn.

(From the Latin *coriarius*—pertaining to leather; the leaves of some species are used for tanning.)

Botanical characters

Characters of the family.

Coriaria nepalensis Wall.

Fl. Brit. Ind., II, 44.

(Mussoorie Berry)

Vernacular names; ALMORA—Makab; BEAS—Armura, Phapharchor, Ratsuhara; CHENAB—Baulu, Shalu; GARHWAL—Gogsa, Makala, Makhio, Makroli; HAZARA—Balel; HINDI—Makola, Masuri; JAUNSAR—Gangaru, Gangeru, Mosroi; JHELUM—Guch; KASHMIR—Tadrelu-balel; KUMAON—Ayar; MUSSOORIE—Mansuri, Masuri; NAINITAL—Makol; NEPAL—Bhojinsi; RAVI—Kande, Rau, Shala; SIMLA—Archarru, Pajerra, Raselva; SUTLEJ—Archalva, Lichakhro, Shere; TONS VALLEY—Gangara, Gangeru.

Botanical characters

A large shrub; branches arching. Leaves 1–4 by $\frac{3}{4}$–$2\frac{1}{2}$ in., opposite, nearly sessile, ovate or elliptic, abruptly short-acuminate, entire or very obscurely serrate, 3–5-nerved. Flowers $\frac{1}{5}$ in. across, greenish, in axillary solitary or clustered racemes 1–4 in. long. Fruit $\frac{1}{5}$–$\frac{1}{3}$ in. diam., of 5 distinct 1-seeded carpels enclosed within the accrescent, purple, succulent petals and separated from one another by the projecting petal-keels.

Distribution

Found in the outer Himalayas from the Indus to Bhutan up to an altitude of 8,000 ft. in the north-west, and to 11,000 ft. in Sikkim; also in Manipur.

Uses and properties

The branches are browsed upon by sheep. The fruit is very insipid but is sometimes eaten, although at times it is reputed to produce thirst and colic. The leaves are said to be used to adulterate senna, and also to act as a powerful poison when given in large doses. The seeds are stated to produce, sometimes, symptoms resembling tetanus (*1*).

It is, however, not exactly known how far the poisonous properties referred to above are, strictly speaking, applicable to *C. nepalensis*, but references to them occur in Indian literature. The leaves bear no resemblance to senna leaves, and it is likely that the poisonous properties of this plant, mentioned in Indian literature, may be the result of information derived from the New Zealand and Mediterranean species which are undoubtedly highly poisonous. According to Watt (*1*), horses are known to eat the leaves freely without any injurious after-effects, and

local people eat the fruit, only maintaining that the seeds should be rejected. Silkworms may be fed on the leaves. According to Stewart (*10*), in one district of the Punjab the plant is looked upon as highly poisonous. The authors' inquiries regarding its poisonous properties, from the inhabitants of the Murree Hills and Kashmir, confirmed the opinion that the " berries " are no doubt occasionally eaten by local people, but never in large quantities; the seed is, however, always discarded. More than 20 " berries " are stated to produce severe headache and giddiness. It appears, therefore, that the Indian plant, although not so poisonous as some of the foreign species, may when taken in excess produce deleterious effects; at any rate, more light is needed on this point.

Constituents

The leaves are stated to contain about 20 per cent of tannins (*11*).

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Family XXVIII.—MORINGACEAE

(Horse-radish Tree Family)

Botanical characters

Trees. Leaves alternate, 2–3-pinnate; pinnae and pinnules imparipinnate, opposite; leaflets opposite, entire, deciduous, and, as well as the pinnae and pinnules, glandular at the base; stipules 0. Flowers irregular, in axillary panicles. Calyx 5-cleft; segments unequal, petaloid. Petals 5, upper smaller, lateral ascending, anterior larger. Stamens inserted on the edge of the disc, declinate, 5 perfect opposite the petals, alternating with 5 (or 7) antherless filaments; anthers 1-celled. Ovary stipitate, 1-celled; ovules many, biseriate on 3 parietal placentas; stigma perforated. Capsule elongate, beaked, 3–6-angled, 1-celled, loculicidally 3-valved, corky. Seeds many, in pits in the valves; testa corky, winged or not.

Distribution

A monogeneric family found in Western Asia and North Africa.

Economic aspects

The leaves, flowers, and pods of the Indian horse-radish tree (*Moringa oleifera* Lam., syn. *M. pterygosperma* Gaertn.) are eaten as a vegetable. The seeds of this as also of the foreign plant *M. aptera* Gaertn. yield "ben oil" of commerce, which is valued as a lubricant by watchmakers, but is seldom extracted and utilized in India.

MORINGA Burm.

(From *muringo*, the Malabar name of *M. oleifera* Lam.)

Botanical characters

Characters of the Family.

Moringa oleifera Lam.

M. pterygosperma Gaertn., Fl. Brit. Ind., II, 45.

(Drumstick Tree, Horse-radish Tree, Indian Horse-radish Tree)

Vernacular names: Almora—Sainjna; Bengal—Sajina, Sajna, Sojna, Sujuna: Bombay—Mangai, Sanga, Saragvo, Segat, Segata, Sekto, Shegla, Shegva, Shivga, Sujna; Burma—Daintha, Dandalonbin, Danthalons; Deccan—Munge-ka-jhar; Garhwal—Sunara, Sundan; Goa—Musing; Gujerat—Midhosaragavo, Saragavo, Segto, Seyla; Haldwani—Sainjna; Hindi—Mungna, Sainjna, Saonjna, Segva, Shajna, Shajnah, Soanjna, Sojna, Sohajna, Sondna: Kanarese—Guggala, Mochaka, Nugge; Kolami—Mulgia; Konkani—Maissing, Moring, Moxing; Lansdowne—Sunara, Sundan; Malayalam—Muringo, Murinna, Sigru, Tishna-gandha; Marathi—Achajhada, Badadishing, Munagacha-jhada, Shevaga, Shevgi; Mundari—Munga; Punjab—Sanjna, Senjna, Soanjna, Sohanjna; Sanskrit—Shobhanjana, Sigru, Sobhanjana; Santal—Munga-arak; Sind—Swanjera; Tamil—Achuram, Asasuram, Karunjanam, Kirañjanam, Kaykkirai, Kilavi, Morunga, Murungai, Sikkuru, Suligai, Tavuselam, Ugaudan, Urudai; Telugu—Advi-

munaga, Karu-munaga, Mulaga, Mulankada, Munga, Muraga, Sajana, Signupa, Tella-munaga; TULU—Nurge; UNITED PROVINCES—Sahajna, Senjna, Sujna; URDU—Sahajna; URIYA—Munigha, Munika, Sajina, Sojina, Sojoba.

Botanical characters

A small or middle-sized tree. Leaves 1–2 ft., usually 3-pinnate. Leaflets $\frac{1}{2}$–$\frac{3}{4}$ in., elliptic, ovate or obovate, nerves obscure. Flowers 1 in. diam., white, honey-scented. Capsule 9–18 in., pendulous, triquetrous, 9-ribbed. Seeds 3-gonous, winged at the angles.

FIG. 62. *Moringa oleifera* Lam.

Distribution

Wild in the Sub-Himalayan tract from the Chenab to Oudh; also commonly cultivated throughout India.

Uses and properties

The leaves, flowers and especially the fruits of this tree are eaten as a vegetable and the foliage is often used as fodder. The seeds yield the " ben oil " of commerce, which is greatly valued by watchmakers and used generally as a lubricant for fine machinery, while perfumers hold it in high esteem, because of its property of absorbing and retaining fugitive odours.

The medicinal properties of this plant have long been appreciated in India. All parts of the plant have been used in the treatment of ascites, rheumatism, venomous bites, and as a cardiac and circulatory stimulant. The pungent root of the young tree has rubefacient and vesicant properties, and has the odour and flavour of the true horse-radish, for which it is used as a substitute. The root-bark has also rubefacient and vesicant properties.

The gum of this plant is said to be used to produce abortion, but reliable information on the point is lacking. It may be possible to use it as a tent to dilate the *os uteri*, as it is tough and swells rapidly when it draws moisture (*1*).

The root-bark in doses of half an ounce, pounded and mixed with 20 black-pepper corns, is used in India to procure abortion, but this is generally accompanied with dangerous and frequently fatal results (*2*). The immature capsules are said to be used as a poison in Kelantan (*3*).

Constituents and action

The root-bark has been analyzed by the authors. An average of 4 assays by different methods showed the presence of 0·105 per cent of alkaloids. Five hundred and thirty-four gm of fresh undried bark when distilled in steam gave only 0·026 gm of an essential oil, which had a very pungent smell. A crystalline base termed moringine was found to be physiologically inert; while the liquid base termed moringinine showed physiological activity (*4*). As the latter could not be isolated in a sufficiently pure condition, the hydrochloride of the liquid base was used in our experiments; its action closely resembled that of ephedrine. This base acts on the sympathetic nerve endings as well as on the cardiac and smooth muscles all over the body. It produces a rise of blood pressure, stimulation of the heart, and contraction of the blood vessels. It also relaxes the bronchioles, inhibits the tone and movements of the intestines, and contracts the uterus in guinea pigs and rabbits. It produces slight diuresis due to a rise of blood pressure, and is detoxicated by the liver. In very large doses the sympathetic motor fibres of the vessels are depressed (*5*).

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Family XXIX.—LEGUMINOSAE

(Pulse or Bean Family)

Botanical characters

Herbs, shrubs or trees. Leaves alternate, rarely opposite or whorled, usually compound, sometimes with the rachis ending in a tendril, stipulate; leaflets often stipellate. Flowers usually irregular, hermaphrodite, rarely regular or polygamous, in axillary leaf-opposed or terminal rocemes or panicles, also in spikes or heads, rarely solitary; bracts and bracteoles usually present. Sepals 5, combined or free, often unequal, sometimes forming a 2-lipped calyx. Petals 5, rarely fewer, usually free and unequal. Stamens normally 10, rarely fewer or indefinite; filaments free or variously combined. Ovary free, almost always monocarpellary, with 1 or more ovules on the ventral suture; style usually declinate. Fruit usually dry, a pod splitting open along both sutures, sometimes continuous and indehiscent, or separating into 1-seeded joints; very rarely drupaceous. Seeds usually exalbuminous.

Distribution

Found all over the world. Papilionatae, the largest subfamily, is cosmopolitan; the other two, Caesalpinioideae and Mimosoideae, are found mostly in the tropical and warm temperate zones.

General remarks

This is the second largest and one of the most important families of flowering plants in the world, with about 500 genera and 12,000 species, many of which are of considerable economic importance. A large number of species are the sources of food or fodder; others yield timber, fibre, dyes, gums and resins, tanning materials, etc. A number of them are used in medicine and some are poisonous. This family probably contains the largest number of plants poisonous to fishes, and also has a number of species which are noted for their insecticidal properties. Another very interesting feature, which gives to this family an outstanding importance, is the power of fixing the free nitrogen of the air by means of the peculiar bacterial organisms, present in the root-nodules of many plants belonging to this family. Through the agency of these nitrogen-fixing bacteria, the fertility of the soil on which these plants are grown is actually enriched instead of being impoverished. This fact has been taken advantage of in economic agriculture, and plants of this family are, therefore, used as a valuable crop on poor soil or as preceding wheat in the rotation of crops. Of the three subfamilies mentioned above, Papilionatae is the most important from the economic and the toxic points of view.

Food and fodder plants

The seeds of many plants of this family are edible, those in common use being: groundnut or peanut (*Arachis hypogaea* Linn.),

gram or chick-pea (*Cicer arietinum* Linn.), pea (*Pisum sativum* Linn.), pigeon pea or 'harhar' [*Cajanus cajan* (Linn.) Millsp., syn. *C. indicus* Spreng.], lentil or 'masur' (*Lens esculenta* Moench, syn. *Ervum lens* Linn.), 'urd' (*Phaseolus mungo* Linn.*, var. *roxburghii* Prain), 'mung' (*Phaseolus radiatus* Linn.*), French bean or kidney bean (*Phaseolus vulgaris* Linn.), Lima bean or Duffin bean (*Phaseolus lunatus* Linn.), 'moth' (*Phaseolus aconitifolius* Jacq.), 'rawan' or 'barbatti' [*Vigna sinensis* (Linn.) Savi *ex* Hassk., syn. *V. catjang* Walp. and *V. catiang* in Fl. Brit. Ind.], soya bean [*Glycine max* (Linn.) Merr., syn. *G. soja* Sieb. & Zucc.], broad bean (*Vicia faba* Linn.), chickling vetch or 'khesari' (*Lathyrus sativus* Linn.), etc. The young pods of 'sem' (*Dolichos lablab* Linn.), jack bean [*Canavalia ensiformis* (Linn.) DC.], cluster bean or 'guar' [*Cyamopsis tetragonoloba* (Linn.) Taub., syn. *C. psoralioides* DC.], tamarind (*Tamarindus indica* Linn.), and some species of *Phaseolus*, *Vigna*, etc., are also edible and are extensively used in this country. Leaves of fenugreek or 'methi' (*Trigonella foenum-graecum* Linn.) are commonly eaten as a vegetable; the tuberous roots of yam bean [*Pachyrhizus erosus* (Linn.) Urban, syn. *P. angulatus* Rich. *ex* DC.] are also edible. Several of the above, as well as horse gram or 'kooltee' (*Dolichos biflorus* Linn.), lucerne or alfalfa (*Medicago sativa* Linn.), clovers and sweet clovers (species of *Trifolium* and *Melilotus*), etc., are used as fodder for cattle in India. In addition, there are numerous wild plants that serve as food for livestock. It is also a well-known fact that in the improvement of natural pastures in the world the leguminous plants play a very important role.

Plants of general interest

Many plants, such as 'sissoo' or 'shisham' (*Dalbergia sissoo* Roxb.), rosewood (*Dalbergia latifolia* Roxb.), ironwood [*Xylia xylocarpa* (Roxb.) Taub., syn. *X. dolabriformis* Benth.], 'siris' [*Albizzia lebbeck* (Linn.) Benth.], 'babul' [*Acacia arabica* (Lam.) Willd.], Australian blackwood (*Acacia melanoxylon* R. Br.), etc., yield valuable timber; the last-mentioned is extensively planted in the Nilgiris. It may be of interest to note here that the heartwood of *Xylia xylocarpa* is resistant to the attacks of white ants; this is due to the presence of a resinous substance. Sunn hemp from *Crotalaria juncea* Linn. is a valuable fibre; 'jayanti' [*Sesbania bispinosa* (Jacq.) Fawcett & Rendle, syn. *S. aculeata* (Willd.) Pers.] also yields a good fibre. Solar hats or 'sola topees' are made from the spongy stems of 'sola' or pith plant (*Aeschynomene aspera* Linn.), a stout aquatic perennial with yellow flowers. The stems tied together are also used as rafts. The spongy pith of this plant

*There has been some confusion with regard to the nomenclature of *Phaseolus mungo* and *P. radiatus*, owing chiefly to Roxburgh having transposed the original Linnean names. Prain (*J. Asiat. Soc. Beng.*, 1898, **66**, 422–423) has helped a great deal in the clarification of this matter.

is also used for widening the narrow openings of sinuses and abscesses and for dilating the *os uteri*. Important dyes are obtained from the indigo plant (*Indigofera tinctoria* Linn.), 'palas' [*Butea monosperma* (Lam.) Kuntze, syn. *B. frondosa* Koen. *ex* Roxb.], catechu [*Acacia catechu* (Linn.) Willd.], sappanwood (*Caesalpinia sappan* Linn.), logwood (*Haematoxylon campechianum* Linn.), etc. ; the last-mentioned plant is cultivated in Indian gardens, and is the source of the well-known laboratory stain haematoxylin. The indigo industry was very important in India before the advent of synthetic dyes. Gum arabic is obtained from *Acacia senegal* Willd. and *A. arabica* (Lam.) Willd., while *Astragalus gummifer* Labill. and other species of *Astragalus* yield the gum tragacanth. *Pterocarpus marsupium* Roxb. is the source of kino, an astringent resin also used for tanning and dyeing purposes. *Acacia catechu* (Linn.) Willd. yields catechu or cutch, a resinous extract used as one of the main ingredients of 'pan' or betel-leaf preparation commonly used in India ; catechu is also used in tanning and dyeing. The barks of 'babul' [*Acacia arabica* (Lam.) Willd.] and tanner's cassia or 'tarwad' (*Cassia auriculata* Linn.) are among the most important tanning materials used in India. The pods of divi-divi or American sumac [*Caesalpinia coriaria* (Jacq.) Willd.] contain important tanning ingredients ; this plant is often cultivated in India. Considerable trade is done in the saponaceous pods of 'shikekai' [*Acacia concinna* (Willd.) DC.] which are used for shampooing and washing. 'Ratti', the seed of *Abrus precatorius* Linn., is extensively used by Indian goldsmiths for weighing gold, silver, etc. The round, strong-scented, yellow flower-heads of *Acacia farnesiana* (Linn.) Willd. constitute the cassie flowers which are largely used in perfumery. An oil is expressed from the seeds of the groundnut or peanut (*Arachis hypogaea* Linn.) which is largely used as a substitute for olive oil.

Of the most familiar plants found in gardens and along roadside in India may be mentioned, in addition to several of the above, the sweet pea (*Lathyrus odoratus* Linn.) with variously coloured flowers ; 'gul mohur' or gold-mohur tree [*Delonix regia* (Boj. *ex* Hook.) Rafin., syn. *Poinciana regia* Boj. *ex* Hook.] with red flowers ; 'asoka' tree (*Saraca indica* Linn.) with brilliant orange-scarlet flowers ; coral tree [*Erythrina variegata* Linn., var. *orientalis* (Linn.) Merr., syn. *E. indica* Lam.] with brilliant scarlet flowers ; Indian laburnum (*Cassia fistula* Linn.), a tree with brilliant yellow flowers ; 'sau' [*Albizzia chinensis* (Osbeck) Merr., syn. *A. stipulata* Boiv.] grown as a tree for its shade and for protecting tea plantations ; colvillea (*Colvillea racemosa* Boj.) with bright orange flowers ; peacock flower or Barbados pride [*Caesalpinia pulcherrima* (Linn.) Sw.] with scarlet or yellow flowers ; *Peltophorum*

inerme (Roxb.) Llanos (*P. ferrugineum* Benth.), a tree with handsome dark-green foliage and rusty panicles of showy yellow flowers; species of *Bauhinia*, etc.

The sensitive plant (*Mimosa pudica* Linn.) is exceedingly sensitive to a touch or a shake, the leaflets closing up rapidly; after about fifteen minutes they slowly assume their normal position. The telegraph plant [*Desmodium gyrans* (Linn. *f.*) DC.] exhibits a very interesting phenomenon, the two small lateral leaflets of each leaf moving steadily round in elliptical orbits during the day if the temperature is not below 72°F.

Medicinal plants

This family contains a large number of medicinal plants, but only some of the more important ones are mentioned below. Liquorice root (*Glycyrrhiza glabra* Linn.) is largely used as a remedy for cough, as a purgative, and also to mask the taste of bitter and nauseous medicines; it contains the glucoside glycyrrhizin. Balsam of tolu is obtained from *Myroxylon toluifera* H. B. & K., a native of Venezuela and New Granada, and contains a volatile oil; the balsam is much used as an expectorant and as an ingredient in cough lozenges.. Calabar or the ordeal bean (*Physostigma venenosum* Balf.), a tropical West African climber with which the natives at one time poisoned their enemies, contains several alkaloids of which physostigmine (eserine) is the most important. It is used in ophthalmic practice to contract the pupils. Senna leaves and pods from *Cassia angustifolia* Vahl and *C. actutifolia* Delile are well known for their laxative and purgative properties. They contain glucosidal compounds which are themselves inactive but are hydrolyzed in the alkaline medium of the intestines, yielding cathartic substances, such as emodin and chrysophanic acid. The pulp of the pod of Indian laburnum or purging cassia (*Cassia fistula* Linn.) is a mild household laxative in India. *Acacia senegal* Willd. and *A. arabica* (Lam.) Willd. are the sources of the gum arabic of medicine which is used for emulsifying oily preparations, but has no real medicinal value. *Astragalus gummifer* Labill. and other species of *Astragalus* of Western Asia yield gum tragacanth, which is used as an excipient for pills and for emulsions to suspend heavy powders in water; none of the species yielding this gum are found in India. The European broom (*Cytisus scoparius* Link) has been used in Western medicine, chiefly as a diuretic; this plant has been introduced in the Nilgiris (Ootacamund), and contains the alkaloids sparteine, sarothamnine and genisteine, and a neutral soluble phenol, scoparin. The diuretic effect is due to scoparin while sparteine resembles coniine in its physiological action. The extract catechu or cutch obtained from *Acacia catechu* (Linn.) Willd. is used as an astringent and in the treatment of burns on account of the tannic acid it contains. The pods of cowhage (*Mucuna prurita* Hook., syn. *M. pruriens* Fl.

Brit. Ind., *non* DC.) are covered with rigid, pointed, brown hairs which, if touched, enter the skin and produce itching; the hairs mixed with honey are used as an anthelmintic.

Poisonous plants

Food and Fodder Poisons.—This family contains a large number of plants which are used as food or fodder. Under certain conditions some of them are known to produce symptoms of poisoning. For details reference may be made to the genera *Canavalia*, *Lathyrus*, *Lupinus*, *Melilotus*, *Phaseolus*, *Trifolium*, and *Vicia* to which these plants belong. In addition it may be noted that lucerne or alfalfa (*Medicago sativa* Linn.), which is one of the most valuable fodder plants, has also been accused of producing tympanitis and even death in livestock. There is, however, no experimental evidence to prove that the plant may at times be injurious, all reports being based only on circumstantial evidence. It is, however, likely that irrational feeding with lucerne may cause tympanitis. Horse gram or 'kooltee' (*Dolichos biflorus* Linn.) is used as fodder and also as food by the poorer classes of people. Watt (*1*) records that "when a spur or ergot grows on the seed, it is often very deleterious."

Piscicidal and Insecticidal Plants.—It has been mentioned above that this family contains the largest number of plants which are poisonous to fishes and that a number of species are important from the insecticidal point of view. These belong to the twenty-seven genera: *Acacia*, *Albizzia*, *Andira*, *Bauhinia*, *Bowdichia*, *Butea*, *Caesalpinia*, *Cassia*, *Centrosema*, *Clitoria*, *Dalbergia*, *Derris*, *Entada*, *Lonchocarpus*, *Millettia*, *Mucuna*, *Muellera*, *Mundulea*, *Nissolia*, *Ougeinia*, *Pachyrhizus*, *Phaseolus*, *Piscidia*, *Pithecellobium* (*Pithecolobium*), *Pongamia*, *Sophora*, and *Tephrosia*. Seven of these, *viz.*, *Andira*, *Bowdichia*, *Centrosema*, *Lonchocarpus*, *Muellera*, *Nissolia*, and *Piscidia*, are not found in India, while *Pachyrhizus erosus* (Linn.) Urban (yam bean) is the only representative of the genus *Pachyrhizus* found in India and that too only under cultivation; this plant yields edible tuberous roots and is not poisonous to fishes. The rest of the genera are represented in India, but none of the Indian representatives of *Bauhinia*, *Clitoria*, *Mucuna*, and *Phaseolus* are recorded as poisonous to fishes or insects. As for the rest, reference may be made to the detailed account of the individual plants of this family.

The question of finding effective insecticides from amongst the plant kingdom has been engaging increasing attention of scientists. Leguminosae as a family is very important from this point of view. Of the above-mentioned genera, some plants belonging to *Butea*, *Derris*, *Lonchocarpus*, *Millettia*, *Mundulea*, *Pongamia*, *Sophora*, and *Tephrosia* have already been recorded as poisonous to insects, and further

search is likely to be fruitful. *Derris elliptica* (Roxb.) Benth. stands foremost as an insecticide of repute and contains several toxic substances (rotenone, deguelin, tephrosin, etc.). It occurs only in Chittagong, so far as India is concerned. Some species of *Lonchocarpus* have assumed an importance as insecticides equal to that of derris. Commercial supplies of these are at present obtained only from Peru and Brazil, where the industry is making considerable headway and reaping enormous profits. This genus is not represented in India. *Tephrosia vogelii* Hook. *f.* of Northern Rhodesia comes next in importance, with tephrosin as the main toxic principle; it is cultivated in the tea gardens of Assam for use as a nitrogenous manure. These plants are indeed effective insecticides, but their use against mosquito larvae may possibly have to be restricted on account of their possessing fish-poisoning properties. It has also been stated that the alkaloid cytisine is an important constituent of the Persian and Australian insect powders. This alkaloid, which resembles nicotine in its action, has been found in an Indian plant, *Sophora tomentosa* Linn., which, however, is not recorded as an insecticide, but the seeds of another plant of the same genus, *S. mollis* R. Grah., are considered useful in destroying vermin. An interesting point to note in this connection is that neither of these two plants nor any other plant containing cytisine is known to be poisonous to fishes. It may be mentioned that cytisine has been reported from the genera *Anagyris*, *Baptisia*, *Euchresta*, *Genista*, *Sophora*, and *Ulex*, all belonging to this family. Of the cytisine-bearing genera, however, only *Euchresta* and *Sophora* are represented in India. It may also be noted that none of the representatives of *Butea* is known to have piscicidal properties.

The aromatic fenugreek or 'methi' (*Trigonella foenum-graecum* Linn.) is used as an insect repellent; agriculturists in the Kangra district, in the Punjab, mix the dried plant with their grains stored up in bags, in order to protect them from attacks of insects during the rainy season.

Plants Poisonous to Higher Animals and Man.—'Ratti' seeds or crab's-eyes (*Abrus precatorius* Linn.) contain a toxalbumin called abrin, which if introduced into the tissues causes rapid death; it has the property of agglutinating the red blood corpuscles. Himalayan laburnum (*Sophora mollis* R. Grah.) of Northern India is reported as poisonous to livestock. Seeds of *Pithecellobium bigeminum* Mart. are eaten by the Burmese people after being specially prepared, but alarming symptoms are sometimes produced; if eaten uncooked they are poisonous. Calabar or the ordeal bean (*Physostigma venenosum* Balf.) of Africa has already been referred to under medicinal plants.

Much has been written regarding the toxicity of the American "locoweeds" (species of *Astragalus* and *Oxytropis*, especially the former), which have been stated to produce in horses, cattle, and sheep a disease called "loco disease" or "locoism"; horses are the principal sufferers. It has also been stated that the loss of livestock due to this disease amounts to about a million dollars per annum in Colorado. Locoism bears some resemblance to the drug habit and the "locoed" animals die from a few months to one or two years. Some foreign species of *Crotalaria* (rattlebushes) are poisonous to animals. *C. burkeana* Benth. of South Africa is stated to be the cause of laminitis in cattle. This condition is an acute inflammatory process in the horn-forming membrane of the hoofs. The animals suffer great pain, the hoofs may reach enormous lengths and thus impede locomotion, but the disease is not usually directly fatal. Some other foreign species of *Crotalaria* are also reported as poisonous to livestock. According to Pammel (*2*), all the Australian species of *Gastrolobium* are more or less poisonous and some of them at least are respiratory or cardiac poisons. This genus is not represented in India. Some species of *Erythrophloeum* are also reported as poisonous. *E. guineense* G. Don (red water tree, sassy bark) of Sierra Leone contains the alkaloids erythrophleine, cassaine, cassaidine, etc. Erythrophleine is a cardiac poison, resembling digitalin, and also possesses local anaesthetic properties (*3*); the bark of this plant is used by native tribes in trials by ordeal. The bark of *E. lasianthum* Corb. of South Africa has been used for homicidal purposes; an alkaloid apparently identical with erythrophleine has been isolated from the bark (*4*). *Erythrophloeum* is not represented in India. *Swainsonia coronillifolia* Salisb. of Australia is a stock poison, producing peripheral neuritis and degeneration of the nerve endings, which results in considerable loss of muscular control and even paralysis. The action takes four to six weeks to develop, and recovery is possible only before the onset of paralysis (*4*). *Swainsonia* is not represented in India. Cases of poisoning due to *Cytisus laburnum* Linn., mostly accidental, have been reported in foreign countries; it contains the alkaloid cytisine which is stated to closely resemble nicotine in its action. This genus is represented in India by a few introduced species of which broom (*Cytisus scoparius* Link) is described in detail hereafter. The seeds of *Elephantorrhiza elephantina* (Burch.) Skeels of South Africa, if eaten or fed to animals, produce symptoms of severe gastro-intestinal irritation; the toxic principles are fairly soluble in water and very slightly, if at all, in absolute alcohol and ether (*5*). *Elephantorrhiza* is not represented in India. The fresh leaves of *Lotononis involucrata* Benth. of South Africa contain a large amount of hydrocyanic acid. Steyn (*5*) experimentally produced diarrhoea and symptoms of hydrocyanic acid poisoning in a sheep by

feeding it on an almost dry plant. A large amount of hydrocyanic acid, however, disappears during drying. Nothing is known about the North Indian *Lotononis leobordea* Benth.

Poisoning in man and animals has also been ascribed to members of the genera *Afzelia*, *Baptisia*, *Caragana*, *Colutea*, *Galega*, *Gompholobium*, *Gymnocladus*, *Lessertia*, *Mirbelia*, *Oxylobium*, *Psoralea*, *Robinia*, *Thermopsis*, etc. Of these, however, only *Caragana*, *Colutea*, *Psoralea*, and *Thermopsis* are represented in India, but none of the Indian species are known to be poisonous.

Constituents

A comparison of the chemical constituents of the three subfamilies belonging to this very large family brings out certain broad and interesting facts. For instance, the subfamily Mimosoideae seems to be fairly rich in saponins and tannins, but is very poor in alkaloids, glucosides, bitter substances, anthraquinone derivatives, balsams and resins, and in toxic compounds of the type of rotenone. Again, the subfamily Caesalpinioideae is very rich in anthraquinone derivatives and in balsams and resins. Many plants contain fair amounts of alkaloids, saponins, and tannins, but this subfamily is poor in glucosides and toxic compounds of the rotenone type. The third subfamily, Papilionatae, is very rich in alkaloids and in toxic compounds of the rotenone type; some plants contain glucosides, saponins, balsams and resins, cyanogenetic compounds, and toxic albumins, but the subfamily is rather poor in anthraquinone derivatives and tannins.

The subfamily Mimosoideae has been found to contain: (*a*) *saponins*, such as those found in the genera *Pithecellobium*, *Albizzia*, *Acacia*, *Entada*, etc., (*b*) *tannins*, such as those found in the genera *Elephantorrhiza*, *Acacia*, *Cassia*, *Piptadenia*, etc., and (*c*) *alkaloids*, such as pithecolobine, etc.

The subfamily Caesalpinioideae has been found to contain: (*a*) *anthraquinone derivatives*, such as emodin, aloe emodin, rhein, kaempferol, chrysophanic acid, oxymethylanthraquinones, etc., (*b*) *balsams* and *resins*, such as those found in the genera *Kingiodendron*, *Hardwickia*, *Copaiba*, *Sindora*, *Prioria*, *Trachylobium*, *Hymenaea*, etc., (*c*) *alkaloids*, such as erythrophleine, homophleine, cassaine, cassaidine, chaksine, *iso*chaksine, etc., (*d*) *saponins*, such as those found in the genera *Gleditschia*, *Gymnocladus*, *Caesalpinia*, *Mezoneurum*, etc., and (*e*) *tannins*, such as those found in the genera *Ceratonia*, *Krameria*, *Caesalpinia*, *Peltophorum*, etc.

The subfamily Papilionatae has been found to contain: (*a*) *alkaloids*, such as cytisine (sophorine), matrine, sophoramine, pachycarpine; ormosine, anagyrine, lupanine, lupanidine, sparteine, hexalupine,

retamine, sarothamnine, genisteine, physostigmine (eserine), eseridine, eseramine, *iso*physostigmine, physovenine, geneserine, etc., (*b*) *toxic compounds*, such as rotenone, tephrosin, deguelin, *iso*tephrosin, toxicarin, dehydrodeguelin, *allo*tephrosin, *iso*deguelin, etc., (*c*) *toxalbumins*, such as abrin, canavalin, concanavalin, etc., (*d*) *glucosides*, such as rutin, osyritin, cyclopin, baptisin, baptin, etc., (*e*) *saponins*, such as those found in the genera *Medicago*, *Trigonella*, etc., (*f*) *balsams* and *resins*, such as those found in the genera *Myroxylon*, *Myrocarpus*, etc., (*g*) *cyanogenetic compounds*, such as those found in the genera *Ornithopus*, *Indigofera*, *Phaseolus*, etc., and (*h*) *anthraquinone derivatives*, such as emodin, etc.

KEY TO THE GENERA*

Subfamily I. PAPILIONATAE. Herbs, shrubs or trees. Corolla papilionaceous; petals irregular, imbricate, the uppermost (standard) outermost, the 2 lateral (wings) intermediate, the 2 lower inside and usually cohering by their lower margin (keel). Stamens 10, rarely fewer, in two bundles (diadelphous) of 9+1 or 5+5, or in one bundle (monadelphous), rarely free.

Tribe I. *Genisteae.* Herbs or shrubs. Leaves simple or digitately 3- (or more-) foliolate. Stamens monadelphous. Pod dehiscent, not jointed.

a. Stamens combined in a tube cleft above. Pod turgid .. 10. *Crotalaria.*

b. Stamens combined in a closed tube .. .. 11. *Cytisus.*

Tribe II. *Trifolieae.* Herbs. Leaves digitately or pinnately 3-foliolate; leaflets usually toothed. Stamens diadelphous. Pod usually dehiscent, not jointed.

a. Leaves digitately 3-foliolate. Flowers in dense heads. Petals persistent, adnate to the staminal tube .. 25. *Trifolium.*

b. Leaves pinnately 3-foliolate. Flowers in long racemes. Petals caducous, free from the staminal tube. Pod short, subglobose or oblong .. .. 16. *Melilotus.*

Tribe III. *Galegeae.* Herbs or shrubs. Leaves imparipinnate; leaflets entire. Stamens usually diadelphous. Pod dehiscent, not jointed.

a. Pod few- or many-seeded, subindehiscent or late in dehiscing.

aa. Mostly climbers. Filaments filiform. Pod woody or very firm .. .. 17. *Millettia.*

bb. Erect shrubs or trees. Alternate filaments dilated 18. *Mundulea.*

b. Pod many-seeded, soon dehiscing.

aa. Flowers mostly in leaf-opposed racemes. Pod flattened, continuous or obscurely septate between the seeds .. .. 24. *Tephrosia.*

bb. Peduncles axillary. Pod turgid, often longitudinally 2-celled, not transversely septate. Keel long, obtuse .. .. 4. *Astragalus.*

Tribe IV. *Hedysareae.* Herbs or shrubs, very rarely trees. Leaves odd-pinnate. Stamens diadelphous or monadelphous. Pod jointed if more than 1-seeded.

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* Medicinal preparations of *Physostigma venenosum* Balf., a foreign plant, are imported into India. This plant as well as foreign species of *Lupinus*, which are used as food and fodder, are also discussed in detail in the following account.

Trees. Leaves stipellate. Racemes in fascicles from the old wood .. .. 19. *Ougeinia.*

Tribe V. *Vicieae.* Herbs or shrubs. Leaves equally pinnate, the rachis ending in a tendril or bristle. Stamens diadelphous (the tenth abortive in *Abrus*). Pod dehiscent, not jointed.

a. Shrubs with the 10th stamen absent .. .. 1. *Abrus.*

b. Herbs with diadelphous stamens (9 and 1); leaflets entire.

aa. Staminal tube oblique at mouth. Style filiform .. 26. *Vicia.*

bb. Staminal tube truncate at mouth. Style flattened at apex .. .. 15. *Lathyrus.*

Tribe VI. *Phaseoleae.* Climbing, rarely erect, herbs or shrubs, rarely trees. Leaves usually pinnately 3-foliolate. Stamens monadelphous or diadelphous. Pod dehiscent, not jointed. Leaves not gland-dotted in the genera discussed below.

a. Style beardless.

aa. Trees or shrubs. Upper lip of calyx not projecting. Stamens diadelphous .. .. .. 5. *Butea.*

bb. Herbs. Upper lip of calyx projecting. Stamens monadelphous .. .. .. 7. *Canavalia.*

b. Style bearded below the stigma.

aa. Stigma oblique. Keel spiral .. .. 20. *Phaseolus.*

bb. Stigma terminal. Petals very unequal in length .. 9. *Clitoria.*

Tribe VII. *Dalbergieae.* Trees or shrubs, sometimes climbing. Leaves odd-pinnate. Stamens monadelphous or diadelphous. Pod continuous, indehiscent.

a. Leaflets alternate. Flowers small, white or reddish .. 12. *Dalbergia.*

b. Leaflets opposite.

aa. Pod flat, almost woody, wingless .. .. 22. *Pongamia.*

bb. Pod flat, thin, firm, winged down one or both sutures .. .. 13. *Derris.*

Tribe VIII. *Sophoreae.* Trees or shrubs (rarely herbs). Leaves odd-pinnate, rarely simple. Stamens free. Pod not jointed.

Stigma terminal. Pod moniliform .. .. 23. *Sophora.*

Subfamily II. CAESALPINIOIDEAE. Trees or shrubs, rarely herbs. Petals imbricate, slightly unequal, the upper innermost in bud. Stamens 10 or fewer, very rarely numerous, usually free.

Tribe IX. *Eucaesalpinieae.* Leaves abruptly bipinnate.

Sutures of pod not winged (rarely slightly winged) .. 6. *Caesalpinia.*

Tribe X. *Cassieae.* Leaves simply pinnate. Calyx-tube short.

Petals 5. Anthers mostly dehiscing by a terminal pore .. 8. *Cassia.*

Subfamily III. MIMOSOIDEAE. Trees or shrubs, rarely herbs. Petals equal, valvate, usually united above the base. Stamens definite or indefinite, free or monadelphous.

Tribe XI. *Mimoseae.* Stamens definite, usually ten.

Large climbers with tendrils and immense pods. Flowers in elongate spikes .. .. 14. *Entada.*

Tribe XII. *Acacieae.* Stamens indefinite.

a. Stamens free .. .. 2. *Acacia.*

b. Stamens monadelphous.

aa. Pod straight, with thin valves .. .. 3. *Albizzia.*

bb. Pod circinate or spirally twisted, with coriaceous valves .. .. 21. *Pithecellobium.*

1. ABRUS Linn.

(From the Greek *habros*—soft ; referring to the softness of the leaves.)

Botanical characters

Climbing shrubs. Leaves pinnate with numerous deciduous leaflets, the rachis ending in a soft bristle. Flowers small, in dense racemes on axillary peduncles or short branches. Calyx campanulate with very short teeth. Corolla exserted; standard ovate, short-clawed, slightly adnate to the staminal tube. Stamens 9, united in a tube slit above, the tenth absent. Ovary many-ovuled; style short, incurved, beardless. Pod oblong or linear, flat or turgid, thinly septate.

Distribution

Tropics.

Abrus precatorius Linn.

Fl. Brit. Ind., II, 175.

(Crab's-eye or Crab's-stone—the seed, Guinea-pea—the seed, Indian Licorice or Indian Liquorice—the root, Jequirity, Rosary Pea—the seed)

Vernacular names: ARABIC—Aainud-dik; ASSAM—Latuwani; BENGAL—Chunhati, Gunch, Kunch, Sonkach; BURMA—Gyin-gwe, Gyin-ywe, Ywegne, Ywegune, Yweguwe; CUTCH—Ratti; DECCAN—Gumchi; GUJERATI—Chanoti, Gunja; HINDI—Chirmiti, Gaungchi, Ghunghachi, Gunchi, Gunja, Kunch, Rakti, Ratti; KANARESE—Galaganji, Gulgunji, Gunja, Gunji, Guruganji, Haga, Kati, Jeshtamadhu; KOL—Karjani; KONKANI—Gunji, Gurugunji; KUMAON—Ratti; LEPCHA—Suhusiligrim; MALAYALAM—Atimadhuram, Irattimadhuram, Kakani, Klitakkam, Kunni, Kunnikkuru, Madhukam, Madhumulam, Shekkunni; MARATHI—Chanoti, Ghungchi, Gunchi, Gunja, Kunch; NEPAL—Lalgeri, Maspati; PERSIAN—Chashme-kharush, Chashm-khuros; PUNJAB—Ghunchi, Labri, Ratak, Ratti; SANSKRIT—Gunja, Kakachinchi, Krishnala; SANTAL—Kawet; TAMIL—Adisamiyai, Gundumani, Kandam, Kunjam, Kunjuram, Kunri, Kunrimani, Kuntumani, Kuruvindam; TELUGU—Ghurie-ghenza, Gurija, Gurivenda, Guruginja, Kukkutamu, Raktika, Sinna-guruginja; URDU—Ghunchi, Ratti; URIYA—Gunja, Kaincho, Kainsho, Kotibopolo, Monda-kainsho, Roti, Runj, Ryunjo.

Botanical characters

A beautiful climbing shrub. Leaves 2–4 in. long; leaflets opposite, 10–20 pairs, $\frac{1}{3}$–$\frac{3}{4}$ in. long, very deciduous, ligulate-oblong, minutely apiculate, glabrous or silky beneath. Flowers $\frac{1}{3}$ in. long, pink or white with a pink tinge, in crowded racemes 1–3 in. long. Pods 1–1$\frac{1}{2}$ in. long, oblong, turgid, 3–5-seeded. Seeds subglobose, polished, usually scarlet with a black eye, sometimes white with a black spot, or uniformly white or black.

Distribution

Found throughout the greater part of India, ascending the outer Himalayas to an altitude of 3,500 ft.; sometimes planted in gardens.

Uses and properties

The red seeds with a black eye, the 'rattis', are largely used by goldsmiths in India as weights, each weighing about 1·75 grains. They are also used for decorating small boxes, baskets, etc., and are made into necklaces and rosaries, hence the name *precatorius*.

Fig. 63. *Abrus precatorius* Linn.

The plant has been used for medicinal purposes by the Hindus from very early times, and is mentioned in the "Susruta". The leaves have a sweetish taste and their juice is used as a cure for hoarseness; mixed with bland oils it is applied to painful swellings. The juice of the fresh leaves is also believed to be effective against leucoderma. The root is sometimes used as a substitute for liquorice, but, although it is said to contain glycyrrhizin, it is a poor substitute (*6*).

The powdered seeds when boiled with milk are said to have powerful tonic effects; if eaten uncooked, they have purgative and emetic properties, and in large doses give rise to symptoms resembling those of cholera (*1*). When taken internally by women, they are believed to disturb the uterine functions and to prevent conception. The active principle (abrin) or an infusion of the seed has been used as an irritant to the eyes (*6*). When introduced into the system by the subcutaneous route, the seeds are very poisonous and are used as a poison in India, Java, and in certain parts of East Africa. They are stated to be sometimes powdered and formed into a paste with which darts, arrows, and daggers are dressed. In India, however, they are more especially employed for criminal poisoning of cattle by sweepers and other low-class people for the sake of their skins, and occasionally for homicidal purposes. The practice, however, is gradually disappearing. For the purpose of poisoning cattle the seeds are ground into a paste and the mass made into small sharp-pointed "needles" ('sui' or 'satari'). These needles, which are about three fourths of an inch in length, are inserted under the skin of the animals, and death results within 18 to 24 hours. Similar needles have also been used to procure criminal abortion, and for this purpose the juice of the plant is also used as a local application.

Constituents

The seeds contain the toxalbumin, "abrin" Later investigations have shown that abrin consists of a globulin and a proteose (*7*). The effects of poisoning with abrin resemble very closely those of the toxalbumin ricin, obtained from the seeds of *Ricinus communis* Linn., and the globulin has been found to be more powerful than the albumose—proteose (*8*). The seeds have also been found to contain a crystalline nitrogenous compound called abrine and an amorphous glucosidic substance abraline with a mild bitter taste (*9*). The leaves are said to contain abrin, and the leaves and roots glycyrrhizin (*10*).

Toxicity and action

The toxicity of the seeds depends upon the manner in which they are administered. The whole seed may be swallowed with impunity, because the outer covering is so hard that it escapes disintegration and the toxin is not freed. If chewed before it is swallowed, half a seed may cause poisoning in man (*11*). Simpson and Bannerjee fed the seeds to

horses, goats, cattle, and dogs in the form of a bolus. The horses showed symptoms of poisoning after having received ½ oz of the seed, while 2 oz sufficed to produce death within 18 hours. The other animals were found to be much more resistant (*12*). The seeds, however, are intensely poisonous: if powdered and introduced under the skin of an animal, they rapidly produce fatal results. They are irritant to the mucous membranes. Other parts of the plant are also stated to possess more or less similar properties.

The absorption of abrin from the gastro-intestinal tract is comparatively slow, and it is partly inactivated by the gastric juice. It is for this reason that abrin when administered orally is almost hundred times less toxic than when administered subcutaneously or intravenously (*5*). Doses of about 1/1,000 to 1/2,000 mgm per kgm body weight injected subcutaneously are said to be poisonous (*6*). Abrin produces very severe irritation of the conjunctiva. This irritant action on the eye was used for the treatment of granular lids and for clearing corneal opacities. It produces an acute inflammation which improves the condition in some cases, but it must be regarded as a dangerous remedy, as it is impossible to control the extent of the inflammation which may be so severe as to destroy the entire eyeball. There is also the risk that sufficient quantities of abrin may be absorbed into the system to cause fatal poisoning (*8*).

The action of abrin is very similar to that of ricin. While abrin is less toxic than ricin, it is a much more powerful irritant to the conjunctiva. When injected into or under the skin, abrin causes severe local irritation and temporary loss of hair at the site of injection. According to Ehrlich, the loss of hair is due to a specific action of the poison on the hair roots (*5*).

Abrin has the property of agglutinating the red blood corpuscles in a manner similar to ricin and it exerts its action after a period of incubation, regardless of the channel of introduction. Ehrlich succeeded in immunizing animals against it, and also prepared an antiabrin serum (*5*). Simpson and Bannerjee showed that in smaller and gradually increasing doses given orally horses develop a tolerance to abrin (*12*). After such immunization, concentrated solutions have no effect on the eye of the animals so treated, nor is there any loss of hair about the site of injection. General immunity can be induced by applying repeated and increasing quantities to the conjunctiva, and Roemer suggested that antibodies are formed in the spleen and bone-marrow. The immunization is specific, that is, animals immunized against other proteinous poisons, such as ricin, are still susceptible to abrin. Ehrlich also found

that the immunity of mice to abrin can be transmitted to the young through the milk (*5*).

Symptoms of poisoning

It is said that there is a latent period of at least several hours and sometimes a day or two before symptoms appear. Kobert (*13*) describes two cases of poisoning of human beings with this plant. In one case, a girl was treated for trachoma of the right eye with an infusion of the plant. A portion of the fluid applied to the eye flowed through the lachrymal duct into the pharynx. Twenty-four hours after the application of the infusion, there was pain in the throat, high fever, swelling of the glands on the right side of the neck, painful swallowing, difficult inspiration, and a croupous pharyngitis. The patient, however, recovered. The second case referred to is that of a man who chewed about half of the inside of the seed (approximately 0·04 gm); the major portion was ejected on account of its bittersweet flavour. In spite of the fact that he swallowed only about 1 mgm of abrin, he developed the following symptoms: Nausea (within an hour), vomiting (twenty times in six hours), severe diarrhoea, weakness, inability to stand, cold perspiration, colic, small and rapid pulse, and trembling of the hands. All these symptoms developed within twelve hours after the seed had been chewed. The patient recovered after treatment. The weakness of the heart, however, lasted for more than six days.

Byam and Archibald (*14*) describe a subnormal temperature after a preliminary rise, albuminuria and, in some cases, convulsions in abrin poisoning.

In the case of animals (horses), the symptoms reported are: Inappetence, violent purging, temperature 104°F. later subnormal, lassitude, shivering, inco-ordination of movement and paralysis (*12*, *15*, *16*).

In animals killed by 'sui' (needle) poisoning, oedema of the subcutaneous tissue is found at the site of injury if the animal has lived over twenty-four to thirty hours; there is also a loss of hair at the site of injury.

Kobert (*13*) states that the action of abrin is much more severe in the carnivora than in the herbivora.

Post-mortem appearance

(*a*) In man, the most outstanding lesions are those of a severe gastro-intestinal irritation. According to Byam and Archibald (*14*), there is agglutination of erythrocytes, some degree of haemolysis, punctiform haemorrhages of the serous surfaces, general enlargement of the lymphatic glands, prominence of Peyer's patches, and a dark and swollen spleen.

(*b*) Simpson and Bannerjee (*12*) report the following *post-mortem* findings in horses: Petechiae in the mouth, pharynx, on the tongue, on the costal and diaphragmatic pleura, on the serosa of almost all organs; thick and tarry blood; pronounced hyperaemia of the lungs with numerous petechiae on the surface; hyperaemia of the kidneys; petechiae

on the spleen; highly inflamed stomach (especially towards pylorus), the mucosa showing a few ulcers and the contents blood stained; hyperaemia of the intestines and contents blood stained; bladder highly congested and containing blood-stained fluid; liver very dark in colour and containing tarry blood.

According to Petri (*17*), there is enlargement of the spleen, blood-stained fluid in the peritoneal cavity, hyperaemia of and petechiae in the serosa, petechiae in the organs, and pronounced swelling of the mesenteric lymphatic glands.

Treatment

Antiabrin serum, if available, should be injected subcutaneously and also given by mouth. The oral administration of pepsin-hydrochloric acid would appear to be indicated, as it exercises a destructive action on the agglutinating properties and toxicity of abrin (*5*). Symptomatic treatment should be applied. Saline purgatives and arecoline seem to be of special value in the treatment of abrin poisoning (*12*, *15*).

Prevention

Active immunization against abrin can be induced not only by means of repeated subcutaneous injections of abrin in nontoxic doses, but also by feeding on small quantities of the plant (seed).

2. ACACIA (Tourn.) Linn.

(From the Greek *akakia*; originally a thorny tree found in Egypt.)

Botanical characters

Trees or erect or climbing shrubs, usually armed. Leaves either 2-pinnate with minute leaflets, or transformed into phyllodes. Stipules sometimes transformed into spines; stipellae 0. Flowers small, in heads or spikes, usually 5-merous, hermaphrodite or polygamous. Calyx campanulate, shortly toothed. Petals exserted, more or less united, rarely free. Stamens many, free or very shortly connate at base; anthers not gland-crested. Ovary many-ovuled. Pod various, not jointed, sutures not thickened.

Distribution

The leaf-bearing groups are cosmopolitan in the tropics, and the great phyllodineous series is almost restricted to Australia.

Acacia pennata (Linn.) Willd.

Fl. Brit. Ind., II, 297.

Vernacular names: Bengal—Kuchui; Burma—Suyit; Dehra Dun—Agia-bel, Agla, Alay; Garhwal—Agalai, Agla; Gujerati—Kherval; Hindi—Aila, Biswul; Kanarese—Kadu-sige, Mullu-sige, Sige; Kolami—Kundaru; Kumaon—Agla, Awal; Lepcha—Baerzhu, Tol-rik; Malayalam—Kattu-sinikka, Sunna; Marathi—Shembati, Shemberti, Shembi, Thembi; Nepal—Arare, Arfu; Porbandar—Jhindhatodi, Khewel, Kheweliobaval; Ramnagar—Agalai,

Agla; SANSKRIT—Ari, Ballikhadira, Khadirapatrika, Sandanika, Silikhadira, Svadikhallari, Uddala; SANTAL—Undaru; TAMIL—Indam-budai, Inda-mullu, Indu, Kattindu, Mullu-chingai, Peychiya-kai, Singai, Singai-mullu; TELUGU—Giddu-korinta, Karusikaya, Mullu-korinta; URIYA—Dontari, Nali-konti, Pota-dontari.

Botanical characters

A large scrambling or climbing shrub, armed with numerous stout slightly hooked or straight prickles (rarely unarmed): young branches pubescent. Leaves 2-pinnate, up to 6 in. long: main rachis with

FIG. 64. *Acacia pennata* (Linn.) Willd.

a projecting gland above the petiole-base, and with smaller glands between the upper pairs of pinnae. Pinnae 8–18 pairs, $1\frac{1}{2}$–$2\frac{1}{2}$ in. long. Leaflets 40–50 pairs, slightly overlapping, $\frac{1}{5}$–$\frac{1}{3}$ by $\frac{1}{20}$ in., sessile, linear, obtuse, glabrous. Flowers white or pale-yellow, in globose pedunculate heads $\frac{3}{8}$–$\frac{1}{2}$ in. diam. arranged in large terminal panicles;

peduncles pubescent, 1–4-nate; bracts linear. Pod stalked, 4–8 by $\frac{3}{4}$–$1\frac{1}{4}$ in., straight, flat, thin, dry, strap-shaped, rounded or shortly apiculate, brown, glabrous, 8–14-seeded.

Distribution

Found in the Central and Eastern Himalayas up to an altitude of 5,000 ft.; also in Oudh, Bengal, Bihar, and in Central, Western and South India. It has also been reported from the North-Western Himalayas.

Toxicity

According to Raizada and Varma (*18*), the fruit and stems are used in Burma for poisoning fish.

3. ALBIZZIA Durazz.

(In honour of *Albizzi*, an Italian naturalist of the eighteenth century.)

Botanical characters

Unarmed trees. Leaves 2-pinnate; stipules usually small, sometimes large and foliaceous. Flowers in globose heads, sessile or pedicellate, hermaphrodite, usually 5-merous. Calyx campanulate or tubular; teeth usually small. Petals connate in a funnel-shaped corolla. Stamens indefinite; filaments monadelphous at the base, long exserted; anthers not gland-crested. Ovary many-ovuled. Pod large, thin, flat, strap-shaped, straight, indehiscent or subindehiscent, continuous within, the sutures not thickened.

Distribution

Warm regions of the Old World.

KEY TO THE SPECIES

a. Leaflets 20–45 pairs, $\frac{1}{3}$–$\frac{1}{2}$ by about $\frac{1}{10}$ in. Stipules large 1. *A. chinensis.*
b. Leaflets 6–16 pairs, 1–2 by $\frac{1}{2}$–1 in. Stipules small 2. *A. procera.*

1. Albizzia chinensis (Osbeck) Merr.

A. stipulata Boiv., Fl. Brit., Ind., II, 300.

Vernacular names: ALMORA—Kala-siri; ASSAM—Sau, Sow; BENGAL—Amlukia, Chakua; BURMA—Bnumoza, Bumaiza; COORG—Kottapali; GARO—Selcho; HINDI—Kala-siris, Kanujera, Pattia, Samsundra, Siran; KANARESE—Bagana, Bage, Betta-bage, Hote-baghi, Hottu-bage, Kal-bage, Kal-baghi; KHOND—Goira, Goiri; KOLAMI—Chapun, Japud, Kera-serum; KONKAN—Phalara, Phalari; KUMAON—Siris; LEPCHA—Singriang; MALAYALAM—Motta-vaka, Pottu-vaka; MARATHI—Udala; NEPAL—Kala-siris; PANCH MAHALS—Shember; PUNJAB—Kasir, Oc, Ohi, Shirsha, Sirin; SANTALI—Chapot; TAMIL—Kat-turanji, Puli-vagai, Silai, Silai-vegai; TELUGU—Chindaga, Chinduga, Konda-chiguru, Konda-chiragu; TULU—Pottu-bage; URIYA—Ghora-lenja, Gudanaudia, Reyi.

Botanical characters

A large tree with broad flat-topped crown. Leaves with 6–20 pairs of pinnae and a large gland on the petiole and smaller ones between the upper pairs of pinnae; stipules large, obliquely cordate, deciduous. Pinnae 2–6 in. long. Leaflets 20–45 pairs, $\frac{1}{3}$–$\frac{1}{2}$ by about $\frac{1}{10}$ in.;

linear-oblong, acute, slightly falcate; midrib very close to the upper edge. Flowers yellowish-white, in peduncled heads arranged in panicles; pedicels $\frac{1}{20}$ in. long. Calyx $\frac{1}{10}$ in. long. Corolla $\frac{1}{5}$–$\frac{1}{4}$ in. long. Pod 4–7 by $\frac{1}{2}$–$\frac{3}{4}$ in., thin, glabrous, light-brown, minutely punctate, late in dehiscing, 8–10-seeded.

Distribution

Found throughout India, ascending to an altitude of 4,000 ft. in the Himalayas.

Uses

This tree is considered to be useful by tea planters who believe that tea flourishes better under its shade than when exposed to the sun, and that its leaves are a good manure for the soil. It yields a gum which exudes copiously from the stem and is used by the Nepalese for sizing their "Daphne" paper. Branches are used for cattle fodder (*1*). An infusion of the bark is used as a lotion for cuts, scabies, and other skin diseases.

Toxicity

Pammel (*2*) records it as a fish poison. It is stated to contain a saponin (*10*).

2. Albizzia procera (Roxb.) Benth.

Fl. Brit. Ind., II, 299.

(White Siris)

Vernacular names: ASSAM—Kori, Koroi; BENGAL—Kori, Koroi, Siris; BHIL—Kinni; BOMBAY—Gurai, Karalla, Karallu, Kilai, Kinai-tihiri, Kurai-tihiri; BURMA—Seet, Sit; DECCAN—Kanalu; DEHRA DUN—Karha, Karhai, Karhar; GARHWAL—Karao; GARO—Khili, Kili; GOND—Passerginni; HINDI—Baro, Garso, Gurar, Gurbari, Gurkur, Karanji, Karhar, Karo, Karolu, Karra, Safed-siris; KANARESE—Adhanji, Bage, Belati, Billai-bage, Chikul, Sala-bage, Sala-yudi; KHOND—Guramanja; KOLAMI—Pandrai; KONKANI—Kinhai; LEPCHA—Takmur; MALAYALAM—Chala-vaka, Karuntakara, Kutam-vaka, Vaka, Vellai-vaka; MARATHI—Kinai, Kinhai, Kinnigurai; NEPAL—Sitto-siris; RAMNAGAR—Karha; TAMIL—Kandai-vagai, Konda-vaghe, Nalla-vagai, Salaiyunjil, Vagai, Vel-vagai; TELUGU—Chigara, Dirisanamu, Ganaru, Konda-dirisanamu, Pedda-pechcharu, Tella-chinduga, Tella-dirisanamu, Tella-sapara; URIYA—Sarapatri, Sirisi, Suropotro, Tentra, Tinia.

Botanical characters

A tall tree with yellowish or greenish-white bark. Leaves with 2–6 pairs of pinnae and a large gland near the petiole-base. Pinnae 5–9 in. long, usually with 1 or 2 glands between the upper pairs of leaflets. Leaflets 6–16 pairs, 1–2 by $\frac{1}{2}$–1 in., ovate-oblong, oblique, obtuse or subacute; midrib nearer the lower edge; petiolules $\frac{1}{20}$ in. long. Flowers sessile, greenish-yellow, in peduncled heads arranged in large lax terminal panicles; peduncles usually in fascicles of 2–5. Pod 4–8 by $\frac{3}{4}$–1 in., glabrous, reddish-brown, thin, flexible, very shortly stalked, 6–12-seeded.

Distribution

Found in the Sub-Himalayan tracts from the Jumna eastwards; also in Bengal, Bihar and Orissa, Central Provinces, Bombay Presidency,

and South India; usually in moist places. It is also occasionally planted as an ornamental or roadside tree.

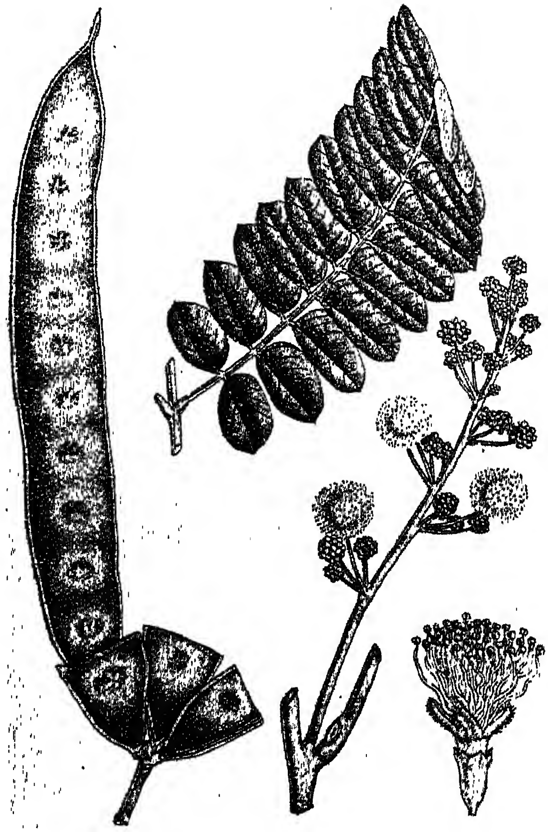

FIG. 65. *Albizzia procera* (Roxb.) Benth.

Uses This tree yields large quantities of gum, and the bark is sometimes used for tanning. It also yields a useful timber.

Toxicity Raizada and Varma (*18*), on the authority of Watt (*1*), state that the bark of this tree, if pounded and thrown into a pond, stupefies fish. We have, however, not found any such reference in his book. Kirtikar and Basu (*19*) mention that the leaves have insecticidal properties; and made into a poultice, they are applied to ulcers.

4. ASTRAGALUS Tourn. *ex* Linn.

(From the Greek name of a shrub supposed to belong to or related to this genus.)

Botanical characters Herbs or shrubs. Leaves pinnate, the rachis terminating either in a leaflet or a spine. Peduncles axillary. Calyx tubular or campanulate,

equal or gibbous on the back; teeth 5, subequal. Corolla usually distinctly exserted; petals usually with rather long claws; keel equalling the wings or a little shorter, incurved, obtuse. Stamens diadelphous. Ovary many-ovulate. Pod linear or oblong, usually turgid, continuous within or more or less completely longitudinally 2-celled from the introversion of the inferior suture.

Distribution Mainly in the north temperate zone, being predominant in Western and Central Asia. Confined in India to the North-Western Himalayas and Western Tibet; scarce towards the Eastern Himalayas. A couple of species are found in the plains of the Punjab and Sind.

Uses This genus consists of some 1,600 species. *A. gummifer* Labill. and some other species yield the well-known tragacanth of medicine and commerce; this is the dried gummy exudation obtained by wounding the stem. Tragacanth is used in pharmacy as an excipient for preparing pills and in emulsions to suspend heavy powders in water, etc.

Toxicity In India, there are about eighty species of *Astragalus* extending from the North-Western Himalayas and Tibet to Sikkim in the east, but nothing is known about their toxicological properties. Much, however, has been written regarding the toxicity of some American species which are connected with the "loco disease" or "locoism" (Spanish *loco*—mad) in horses, cattle, and sheep in America, but horses are the principal sufferers. This disease is very common in America and causes considerable loss, particularly in Colorado and Montana.

Locoism It has been stated that when there is plenty of other fodder available most animals do not eat locoweeds, but once they happen to eat them they will frequently browse upon them eventually with fatal results. Locoism in this respect bears some resemblance to a drug habit and two stages of this disease are recognized. The symptoms consist in motor inco-ordination, forced movements, misjudgment of distances, stupidity, and apparent hallucinations. In the chronic form, there is progressive emaciation and craziness. Death takes place from a few months to one or two years and is preceded by coma and convulsions.

The aetiology of these conditions is obscure, and the disease has not been associated with any chemical constituent of the implicated plants. It is generally attributed to feeding on certain leguminous plants called "locoweeds" mostly belonging to this genus and to some extent to those belonging to the genus *Oxytropis*. Both the green plants and the dry tops of the locoweeds are considered poisonous, and it has

been stated that their toxicity varies considerably, depending upon the soil on which they grow. Some have attributed their toxicity to barium.

Marsh (*20*) claims to have reproduced the condition (nervous symptoms, etc., with exudative meningitis, anaemia, etc.) experimentally by long-continued feeding with locoweeds; but Marshall, according to Sollmann (*21*), considers the results inconclusive and believes that there is no distinct loco disease and that the name covers a variety of conditions—malnutrition, parasitism, etc.—unconnected with locoweed.

Treatment

For horses arsenic is recommended in the form of Fowler's solution, in doses of 4 to 6 drachms daily, and for cattle strychnine in doses of $\frac{3}{20}$ to $\frac{4}{20}$ grains daily may be given subcutaneously for about 30 days (*22*).

It may be mentioned here that the seeds of *A. hamosus* Linn. of the plains of the Punjab and the North-West Frontier Province, and the foreign species *A. baeticus* Linn., *A. galegiformis* Linn., and *A. maximus* Willd. contain saponins (*10*).

5. BUTEA Koen. *ex* Roxb.

(In honour of John, Earl of *Bute*, a patron of botany in the eighteenth century.)

Botanical characters

Trees or large climbing shrubs. Leaves pinnately 3-foliolate, stipellate. Flowers large, showy, densely fascicled on the tumid nodes of racemes or panicles. Calyx broadly campanulate; teeth short, deltoid. Corolla much exserted; petals subequal or unequal; keel incurved and acute or straight and obtuse. Stamens diadelphous. Ovary 2-ovuled; style beardless. Pod firm, oblong or broadly linear, splitting round the single apical seed, indehiscent below.

Distribution

Tropical Asia.

Butea monosperma (Lam.) Kuntze

B. frondosa Koen. *ex* Roxb., Fl. Brit. Ind., **II**, 194.

(Bastard Teak, Bengal Kino, Butea Gum)

Vernacular names: BENGAL—Palas, Polashi; BIHAR—Faras, Paras; BUNDELKHAND—Chalcha; BURMA—Pav, Pauk, Pin, Pouk, Poukpen; CENTRAL PROVINCES—Chinta, Chiula, Puroha-palas; CUTCH—Khakar, Palas; DECCAN—Palas, Tesu; GOND—Murr; GUJERATI—Kakria, Khakara, Khakhado, Khakharo, Palasso, Phulas; HINDI—Chichra, Desu, Dhak, Kakria, Kankrei, Palah, Palas, Tesa, Tesu; KANARESE—Brahma-vriksha, Muttala, Muttuga, Palasa; KOLAMI—Morud, Murut; KUMAON—Dhak, Palas; LEPCHA—Lahokung; MALAYALAM—Brahma-vriksham, Kimshukam, Mukka-puyam, Muriku, Murukka-maram, Palasi, Palasinjamata, Palasinsamatha, Plachcha, Puppalasi, Shamata; MARATHI—Kakra, Palas, Paras, Phalasa, Phulas; NEPAL—Bulyettra, Palasi; PERSIAN—Palah; PUNJAB—Dhak, Kesu, Maljan, Marwar, Palas, Taur; SANSKRIT—Kinsuka, Palasa;

SANTAL—Murup; TAMIL—Kali, Kattu-murukku, Kinjugam, Kirumi-satturu, Murukhan, Murukku, Palasu, Palasham, Porasan, Porasu, Puna-murukku, Puna-murrungai, Pungu, Puppalasu, Puraishu, Purasu, Sira, Tikkuru, Vadabodam, Vallai, Vallai-purasu; TELUGU—Kimsukamu, Modaga-mardulu, Moduga, Mohtu, Motuku, Palas, Palasamu, Palashamu, Tella-moduga, Togaru-moduga, Vatapodhamu; TULU—Palasa; URDU—Palashpapra; URIYA—Kinjuko, Polaso, Porasu.

Botanical characters

A small or medium-sized tree with usually crooked trunk. Leaflets 4–8 in. long and broad, rigidly coriaceous, glabrescent above, silky-tomentose and strongly veined beneath; terminal one rhomboid from a

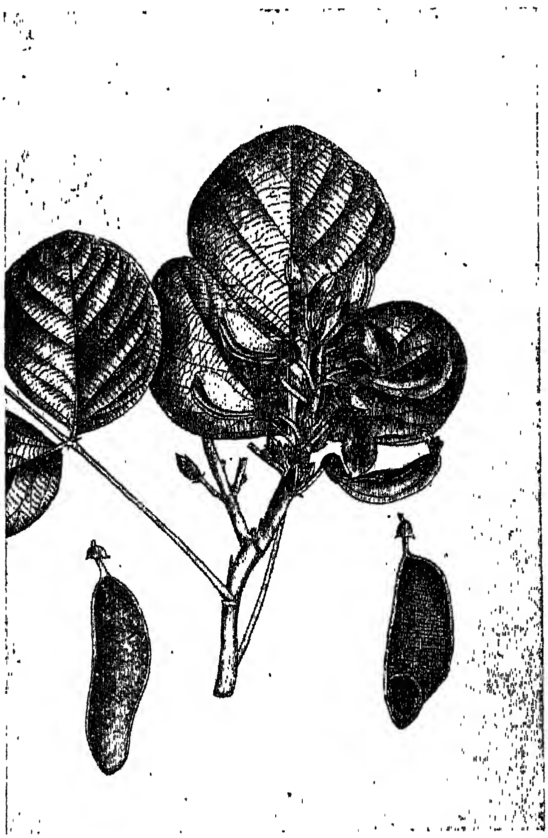

FIG. 66. *Butea monosperma* (Lam.) Kuntze

cuneate base or obovate, obtuse or emarginate; lateral obliquely ovate. Flowers scarlet and orange, 1½–2 in. long, borne in great profusion on the usually leafless branches. Calyx dark-velvety; the upper 2 teeth connate, lower 3 deltoid. Corolla silvery-tomentose

outside ; keel much curved, acute. Pod 4–8 by 1–2 in., downy, stalked. Seed oval, compressed, brown, 1½ in. long.

Distribution

Common throughout the greater part of India, ascending to an altitude of 3,000 ft. and in some places even up to 4,000 ft.

Uses and properties

It is a very beautiful tree nearly every part of which is put to some use. It is one of the most important host plants for lac insects, but, although the quantity of lac produced is larger, the quality is not so good as from some other trees. The flowers yield a brilliant but not fast yellow dye which is largely used during the 'holi' festival of the Hindus. The leaves are extensively employed for preparing plates ('pattal') from which food is taken and also for wrapping up parcels ; they are also used as fodder for buffaloes and elephants, though they are not eaten by goats ; hence the proverb 'Unt se ak bakri se dhak' [camels shun the 'ak'—*Calotropis procera* (Linn.) Dryand.—and goats the 'dhak'—*Butea monosperma*].

The tree yields naturally or from artificial incisions on the bark a gum which is sold as "Bengal Kino". The gum is largely used in medicine as an astringent and as a substitute for "kino" in India, and to a limited extent in Europe as well ; it is also employed in tanning. The flowers and leaves are said to possess astringent, diuretic, and aphrodisiac properties ; made into a poultice they are used as an antiphlogistic application for swellings and boils.

The seeds have been administered internally, either in the form of a powder or as a paste made with honey, as an anthelmintic from very ancient times. Considerable difference of opinion, however, exists with regard to their action. Some experiments indicate that the drug is almost at par with santonin, while the results in other cases are disappointing. The oil, the powdered seeds, and the alcoholic extract made from the seeds were found to be quite ineffective against hookworms. In the case of roundworms (*Ascaris lumbricoides*), the action of the seeds is erratic. Good results were obtained with freshly powdered seeds against ascaris, whereas the old worm-eaten seeds, as are frequently met with in the market, are of little value. The seeds are very unpleasant to take and often produce retching, pain in the abdomen, and occasionally vomiting and giddiness (*23*).

Insecticide

Externally the seeds, when pounded with lemon juice and applied to the skin, act as a rubefacient ; when made into a paste, they are used as a remedy against ringworm (*1*). Maggots are killed by sprinkling powdered seeds over them (*19*).

Constituents

The seeds contain 18 per cent of a fixed oil called moodooga oil or kino-tree oil, a small quantity of a resin, and a large quantity of a

water-soluble albuminoid (*6*). Recently the seeds have been shown to contain lipolytic and proteolytic enzymes (*24*).

6. CAESALPINIA Linn.

(In honour of Andreas *Caesalpini*, professor of medicine at Pisa in the sixteenth century. He was the first botanist to classify plants by the flowers and fruits.)

Botanical characters

Trees or shrubs or climbers, armed or not. Leaves large, abruptly bipinnate. Flowers showy, yellow or red, in copious axillary racemes, more rarely racemes terminal and panicled. Calyx-lobes imbricate, the lowest the largest, hood-shaped; tube very short. Petals spreading, usually orbicular and clawed, the uppermost smallest. Stamens 10, free, declinate; filaments often woolly. Ovary few-ovuled. Pod oblong or ligulate, flat or turgid, dehiscent or not, smooth or prickly, not winged (a rudimentary wing is sometimes present).

Distribution

Tropical and subtropical regions.

Caesalpinia nuga (Linn.) Ait.

Fl. Brit. Ind., II, 255.

Vernacular names: BURMA—Sakauk, Sugauk; MALAYALAM—Kaka-mullu, Kaku-mullu; SUNDARBANS—Netu, Shingri-lota; TELUGU—Mulutige.

Botanical characters

A large prickly climber with hooked prickles on the branches, at the base of the pinnae, and along the rachis of the leaves above. Pinnae 2–4 pairs. Leaflets 2–3 pairs, 1–2 by $\frac{1}{2}$–1 in., ovate or elliptic, subacute, glabrous and shining above, dull beneath. Flowers $\frac{1}{2}$ in. across, yellow, fragrant, in panicled racemes. Filaments woolly below. Pod 2–2$\frac{1}{4}$ by 1$\frac{3}{8}$ in., obliquely oblong-ellipsoid, beaked, compressed, woody, 1-seeded.

Distribution

A littoral species found on the banks of rivers near the coast, *e.g.*, in Konkan, West Coast, Orissa, Sundarbans and Eastern Bengal near Chittagong, and in Sylhet.

Uses

The root of this plant has been stated to possess diuretic properties, and to be useful against gravel and stone in the bladder. The juice of the stem is used both externally and internally in eye diseases. Roasted fruits are also used for the same purpose. The finely powdered leaves have been administered as a uterine tonic to women immediately after delivery (*1*).

Toxicity

According to Raizada and Varma (*18*), the pulped fruit and stems of this plant yield a fish poison.

FIG. 67. *Caesalpinia nuga* (Linn.) Ait.

7. CANAVALIA DC.

(From the Malabar name, *kanavala*, of one of the species.)

Botanical characters

Large climbing or prostrate herbs with stipellate 3-foliolate leaves. Flowers showy, in racemes with tumid nodes. Calyx bilabiate; the upper lip projecting, entire or emarginate, lower shortly 3-toothed. Corolla much exserted; standard large, roundish; wings shorter, equalling the incurved obtuse keel. Stamens monadelphous, or posterior free at the base. Ovary many-ovuled; style beardless. Pod large, linear or linear-oblong, somewhat compressed, with the upper suture strongly 2-ribbed.

Distribution

Warmer regions of both hemispheres.

Canavalia virosa Wight & Arn.

C. ensiformis (Linn.) DC., var. *virosa* Baker, Fl. Brit. Ind., II, 196.

Vernacular names: BENGAL—Kala-shim, Kath-shim; BOMBAY—Assambal, Gaivara, Gowara; HINDI—Kadsambal, Sem; KANARESE—Kad-avare; MALAYALAM—Kattu-valamara; MARATHI—Abai; MUNDARI—Tiun; TAMIL—Kuttu-tambattan, Segapu; TELUGU—Adavi-tamma, Kara-nupu-tige, Karu-tamma, Tumbetten-kaya; URIYA—Bahara, Kola simo. Mohrhorha, Nohupiya-simo.

Botanical characters

A climbing perennial usually with reddish and tougher stems than in *C. ensiformis*. Terminal leaflet $1\frac{1}{2}$–4 in. long, rarely $5\frac{1}{2}$ in., broadly elliptic-oblong or broadly ovate with a rounded tip and short cusp or obtuse, rarely acute or subacuminate, base rounded. Flowers lilac-purple, $1\frac{1}{5}$ in. long. Calyx puberulous. Standard with two strong

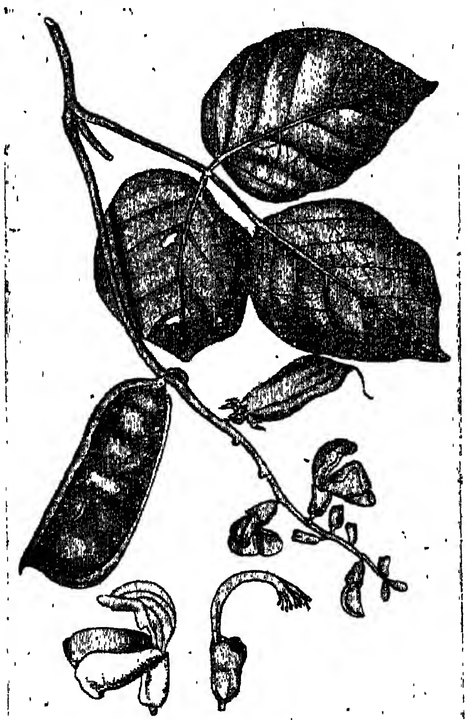

FIG. 68. *Canavalia virosa* Wight & Arn.

calli above the claw. Ovary silky, tapering into the style. Pod up to 7 by $1\frac{1}{2}$ in. but often much smaller (4–5 in.), nearly straight, brownish when ripe. Seeds 4–8, ellipsoid or somewhat ovoid, $\frac{3}{5}$–$\frac{7}{10}$ in. long, much less compressed than in *C. ensiformis*, marbled with light and darker brown; hilum $\frac{1}{2}$ in. long.

Distribution

Found wild in Bundelkhand, Purnea, Puri, Angul, and other parts of India, such as the Deccan, Carnatic, Konkan, Belgaum, Bengal, the United Provinces, etc.

Toxicity

This plant is accredited with poisonous properties. Roxburgh describing it under *Dolichos virosus* in " Flora Indica " says : " I do not find that any part of this species is in any shape useful to the natives, or others ; indeed the natives of Coromandel, where the plant is common, reckon it poisonous, which is corroborated by Van Rheed (*sic*) ". Haines (*25*) mentions that the seeds are poisonous, but adds that the young pods are sometimes eaten ; the former are said to have a bitter taste.

The plant is very closely allied to *C. ensiformis* (Linn.) DC. (jack bean, sword bean, broad bean, Patagonian bean) ; the latter is cultivated throughout India for the sake of its young tender pods and seeds which are used as vegetables. *C. ensiformis* is a perennial or biennial herb, but, according to Haines (*25*), it " is usually grown as an annual, as the natives say that subsequent crops of seeds are more or less poisonous ". This seems to be interesting in view of the fact that *C. virosa*, a wild perennial, is reported to be poisonous.

Constituents

The seeds of *C. ensiformis* contain three globulins, concanavalin A, concanavalin B, and canavalin (*26*) ; of these concanavalin A has been shown to be toxic to rabbits when a sufficiently large dose is injected (*27*).

8. CASSIA Tourn. *ex* Linn.

(The classical name of some tree with aromatic bark.)

Botanical characters

Trees or shrubs, rarely herbs. Leaves abruptly pinnate, the rachis often with glands between the leaflets or on the petiole below them. Flowers usually yellow, often large, in axillary racemes and terminal panicles, rarely in axillary pairs. Calyx-tube very short. Petals 5, subequal or the lower largest. Stamens 10, frequently unequal or some reduced to staminodes ; anthers dehiscing by a short slit or terminal pore. Ovary linear, many-ovuled. Pod variable, terete or flat, dehiscent or not, usually septate. Seeds flattened.

Distribution

Tropical and warm temperate regions.

Medicinal aspects

This genus is of considerable importance from the medicinal point of view, and some of the species are widely used for their cathartic properties. Senna leaves, which are well known in Western medicine for their laxative and purgative effects, are derived from *C. angustifolia* Vahl (Indian senna, Tinnevelly senna, Arabian senna) and *C. acutifolia* Delile (Alexandrian senna). The pods of these species are also used for the same purpose. *C. angustifolia* is largely cultivated in the Madras and

Bombay Presidencies, especially in Tinnevelly. *C. acutifolia* has also been cultivated in India.

Senna belongs to the anthraquinone or emodin group of cathartics to which also belong rhubarb (*Rheum*), cascara (*Rhamnus*), aloes (*Aloe*), and other related drugs. This group contains glucosidal compounds which are themselves inactive, but in the alkaline medium of the intestines they are hydrolyzed or oxidized, yielding various oxymethylanthraquinones, which have a cathartic action. The most common of these substances are emodin and chrysophanic acid, which in a pure state are irritants, but their action is graded by their slow liberation and by the presence of colloidal extractives. The special features of the different drugs are probably due to differences in their isomers, in the stability of their glucosidal combination, and to the presence of other associated substances. The action of these drugs does not result in inflammation (*21*).

The effects of senna are more extensive and more irritant than those of other drugs of this group. There is considerable griping, but this may be corrected by carminatives or by the previous extraction of the resins with alcohol (*21*).

C. obovata Collad. (Italian senna), which grows wild in Baluchistan, Sind, the Punjab, Gujerat, Southern Mahratta Country and the Deccan, is largely sold in Indian bazars under the name of " country senna " as a substitute for the officially recognized drug. Steyn (*28*) drenched a sheep with 500 gm of the dry plant in the flowering stage without any effect ; he reports that the plant is alleged to have caused heavy mortality in goats, but tests on a goat and rabbits proved negative. Maurin (*29*) has isolated about 1 per cent of oxymethylanthraquinones from the leaves.

The pulp of the fruit of *C. fistula* Linn. (drumstick tree, Indian laburnum, purging cassia) is one of the commonest and most useful of domestic medicines ; it acts as a simple purgative. Maurin (*30*) has isolated oxymethylanthraquinone from the plant—entire fruit 0·95 per cent, fruit pulp 1·05 per cent, and the bark of the twigs 1·20 per cent.

C. occidentalis Linn. (negro coffee, foetid cassia) acts as a cathartic. Moussu (*31*) found the seeds to contain a toxalbumin. Straub and Gebhardt (*32*) reported the presence in the leaves of an active cathartic substance of the nature of anthranol glucoside and a relatively ineffective second crystalline glucoside.

C. sophera Linn. has the same medicinal properties as *C. occidentalis* ; various parts of the plant are used as a remedy for ringworm.

The powdered seeds of *C. absus* Linn. are commonly used for eye conditions, especially conjunctivitis, but it is a dangerous remedy in

catarrhal ophthalmia and granular eyelids and produces a great deal of pain. The seeds are also used in indigenous medicine to purify the blood ; they contain the bases (*33*) chaksine and *iso*chaksine.

Cassia alata Linn.

Fl. Brit. Ind., II, 264.

(French Guava, Ringworm Shrub)

Vernacular names : BENGAL—Dad-mardan, Dad-mari ; BURMA—Maizali-gi, Simbo-maizali, Timbo-mezali ; DECCAN—Vilayati-agati ; HINDI—Dad-murdan, Dad-ka-pat ; KANARESE—Dodda-sagate, Simay-agase ; MALAYALAM—Elakajam, Simay-akatti; MARATHI—Dada-mardana ; SANSKRIT—Dadrughna, Dvipagasti ; TAMIL—Simaiy-agatti, Vandukolli ; TELUGU—Mettatamara. Sima-avisi, Simay-avisa ; TULU—Daddu-mardu, Puritappu ; URIYA—Dadu-morddono, Jadu-mari.

FIG. 69. *Cassia alata* Linn.

Botanical characters

A shrub with very thick finely downy branches. Leaves subsessile, 1–2 ft. long; rachis without glands; stipules deltoid, persistent. Leaflets 16–28, 2–6 in. long, oblong, minutely mucronate, oblique at the base. Racemes long-peduncled, narrow, $\frac{1}{2}$–1 ft. Corolla yellow, distinctly veined. Pod 4–8 by $\frac{1}{2}$–$\frac{5}{8}$ in., ligulate, with a broad wing down the middle of each valve, membranous, straight, glabrous, dehiscent. Seeds 50 or more.

Distribution

Met with in lower Bengal; probably an introduced plant since it does not occur far away from residential places.

Uses and properties

The bark of this plant is used as a tanning material. The leaves are esteemed as a local application in skin diseases, especially for ringworm; for this purpose both the fresh leaves and an ointment prepared from them are used. The leaves have also been stated to possess purgative properties.

The plant has been recorded as poisonous to fishes (*2*).

The fruits contain oxymethylanthraquinones (*10*).

It would be interesting to investigate the piscicidal properties of other species of *Cassia*, especially some of those that have been discussed above and are found to contain similar active principles.

9. CLITORIA Linn.

(From *clitoris*, a small organ of the female anatomy, from the Greek *kleitoris*, from *kleio*—to hide, to shut up; it is concealed by the labia minora; referring to the shape of flowers.)

Botanical characters

Herbs or shrubs, erect or climbing. Leaves pinnately 3–7-foliolate; stipules persistent, striate. Leaflets stipellate. Flowers showy, axillary, solitary, fascicled or racemose. This genus differs from the allied genera in the spoon-shaped standard far exceeding the wings and keel. Stamens diadelphous or monadelphous. Ovary stalked. Style incurved, flattened, bearded along the inner side. Pod linear, compressed or turgid.

Distribution

Warmer regions of the world.

Clitoria ternatea Linn.

Fl. Brit. Ind., II, 208.

(Butterfly Pea, Mussel-shell Creeper)

Vernacular names: Arabic—Bazrul-mazariyune-hindi, Mazariyune-hindi; Bengal—Aparajita, Nil-aparajita, Swet-aparajita, Uparajita; Bombay—Gokaran, Gokarna, Kajali, Supli; Burma—Bukiyu, Bukyu, Oung mai phyu, Pai noung ni; Deccan—Ghutti, Kalizer, Phiki; Gujerat—Garani, Koyala; Hindi—Aprajit, Aparajita, Kajina, Kalina, Kalizer, Kava-thenthi,

Khagin, Kova, Kova-theti, Shobanjan, Vishnukranti ; KANARESE—Gokarnamul, Girikarni-balli, Kirgunna, Sankhapushpa-balli, Vishnukanti-soppu ; KONKANI—Kazuli ; MALAYALAM—Aral, Kakkanam-koti, Sankhankuppi, Sankhapushpam, Sholongo-kuspi ; MARATHI—Gokaran, Gokarni, Gokurna, Kajili, Sholonga ; PERSIAN—Bikho-hayat ; PUSHTU—Aparajita, Aprajit, Dhanattar, Ghiria, Isband, Kalzar, Kavatunti, Nil-isband, Nil-kanth ; SANSKRIT—Aparajita, Asphota, Gokarnamul, Khurne, Nilaghiria, Nilaghiric kurni, Vishnukranta, TAMIL—Kakkanam, Kakkanan-kodi, Kakkattan, Kanni-kodi, Karakartan, Karisanni, Karkakartum, Karkkurattai, Karudakkovai, Karudattondai, Karuvilai, Kaurigeni, Kavalai, Kemachi, Kevari, Kigini, Kiriganni, Kiruttini, Minni, Taruganni, Uyavai, Viranu ; TELUGU—Dintana, Dintena, Mella, Nalla-ghentana, Nalla-vusinitige, Nila-dintana, Tella-dintana ; TULU—Sanka ; URDU—Mazeriyuni-hindi ; URIYA—Onasi, Oporajita.

Botanical characters

A pretty slender twiner with terete downy stems. Leaves 4 in. long ; petiole $\frac{3}{4}$ in. ; leaflets 1–2 in. long, ovate or oblong, obtuse. Flowers solitary, axillary, $1\frac{1}{2}$–2 in. long, bright-blue with an orange centre, or

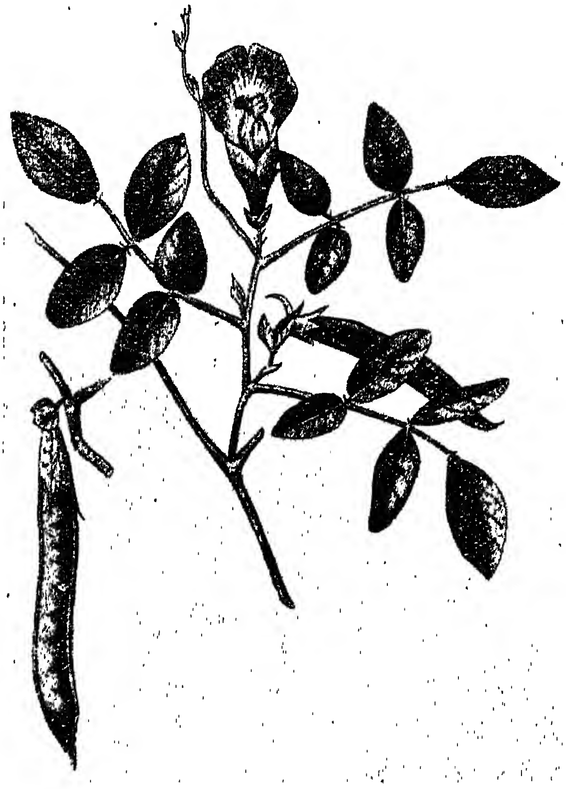

FIG. 70. *Clitoria ternatea* Linn.

white ; bracteoles large, obtuse. Pod 2–4 in. long, flattish, sparingly hairy, 6–10-seeded.

Distribution

A common garden plant; also occurs among hedges all over the tropical region from the Himalayas to Ceylon.

Uses and properties

A dye is obtained from the flowers or seeds, and various parts of the plant are used in indigenous medicine. The root acts as a powerful cathartic in the same way as jalap, but opinions differ with regard to its emetic properties. According to O'Shaughnessy, an alcoholic extract of the roots acts as a brisk purgative in doses of 5 to 10 grains, but griping and tenesmus are often produced and the patient feels feverish and uneasy. It is not advisable, therefore, to use it as a medicine. The seeds are, however, more useful and considered as a safe medicine; in the powdered form, they have purgative and aperient properties. The roots are supposed to act as an antidote against snake bite, and an infusion of the leaves is said to be used against eruptive conditions (*1*).

10. CROTALARIA Dill. *ex* Linn.

(From the Greek *krotalon*—a rattle; referring to the rattling of the seeds in the inflated pods when shaken.)

Botanical characters

Herbs, shrubs or undershrubs. Leaves simple or 3-foliolate, rarely 5–7-foliolate. Flowers in terminal or leaf-opposed racemes, usually yellow, often showy. Calyx-tube short; teeth linear or lanceolate, subequal or more or less connate in 2 lips. Corolla exserted or not; standard usually broad, shortly clawed; keel-petals connate into a conspicuously incurved beak. Stamens monadelphous; anthers dimorphous. Ovary rarely 2- usually many-ovuled. Style long, abruptly incurved at the base, bearded upwards. Pod usually sessile, straight, very turgid, without septa, usually many-seeded.

Distribution

Tropical and subtropical regions of the globe.

Uses and properties

Over seventy species of *Crotalaria* are found in India. Of these, *C. juncea* Linn. is a well-known plant cultivated for the fibre that is obtained from its stems by maceration in water; it is known as sunn hemp, Indian hemp, false hemp, etc. Nothing is known about the toxicological properties of the various species found in India, but we give below the toxic effects produced by some of the foreign species.

Crotalism

The South African *C. burkeana* Benth. is believed to be the cause of "styfsiekte", "stijfziekte", "stywesiekte" or "stiff-sickness" in livestock, and Theiler (*34*) has proved by direct experiments that the plant is the cause of the laminitic form of crotalism in cattle. This condition is an acute inflammatory process in the horn-forming membrane of the hoofs. The animals suffer great pain and can move

about only with great difficulty. Later, the pain decreases but they still walk stiffly. The hoofs grow out and may reach enormous lengths, thus impeding locomotion. The disease is not usually directly fatal, and, according to Theiler, the plant is dangerous only if eaten in a fresh condition. No active constituent, which would account for this disease, has yet been isolated from the plant.

Missouri-bottom disease

C. sagittalis Linn. or rattlebox of the Eastern and Central United States is reported to be the cause of a disease known as "Missouri-bottom disease", so called on account of its prevalence along the Missouri river bed. This disease affects horses and, in most cases, is very slow in its progress; it almost uniformly proves fatal after a number of weeks or months. There is a general decline of bodily vigour throughout this period, marked emaciation, and consequent weakness. In a number of cases, marked coma or stupor has been observed, the animal often falling asleep while eating. A large number of horses are reported to die annually by consuming this plant, and Pammel concludes that rattlebox is decidedly injurious under certain circumstances (*2*).

11. CYTISUS Linn.

(From the Latin *cytisus*, a plant, probably a medic, from the Greek *kytisos*.)

Botanical characters

Shrubs with green, angular stems. Leaves small, 1–3-foliolate or 0. Flowers yellow, white or purple, solitary or fascicled in the leaf-axils. Calyx with 2 short broad lips. Standard large; wings oblong; keel obtuse, deflexed after flowering. Stamens combined into a closed tube; anthers alternately long and basifixed, and short and versatile. Style incurved or coiled. Pod flat, elongate, 2-valved. Seeds many, strophiolate.

Distribution

Mostly in the countries bordering on the Mediterranean.

Toxic aspects

None of the species belonging to this genus is indigenous to India, but a few of them have been introduced into South India. Of these, *C. scoparius* Link is dealt with in detail hereafter because of its possible toxic effects due to the presence of certain toxic alkaloids. It is also proposed to draw attention to the following foreign poisonous representative of the genus, which is sometimes cultivated in the hill stations of the North-Western Himalayas.

Several cases of poisoning due to *C. laburnum* Linn., mostly accidental, have been reported in Europe. All parts of the plant have produced serious symptoms of poisoning, especially in man, while poisoning in livestock is very rarely reported. Symptoms of poisoning due to the eating of the flowers, seeds or other portions of the plant are mainly referable to the gastro-intestinal tract and consist of acute pain in the

stomach, vomiting, and diarrhoea. In the case of poisoning with roots, vomiting followed by narcosis, with convulsive movements of the legs and strange movements of the arms, and dilated pupils have been reported (*35*).

Cytisine (sophorine) is the alkaloid reported from the seeds, leaves, and the racemes of flowers, the seeds being richest in their alkaloidal content (*36*). From the symptoms described above it is more than probable that there is another active principle present in the root.

Cytisine is a powerful poison which causes nausea, convulsions, and death by asphyxiation. In small doses, the hydrobromide has been suggested as a diuretic (*37*). According to Dale and Laidlaw (*38*), it closely resembles nicotine in its physiological action.

Insecticidal properties

Cytisine is said to be the active constituent of Persian and Australian insect powders (*39*). Besides laburnum, it is known to occur in several other plants of this family, especially in their seeds. These plants belong to the genera *Ulex*, *Baptisia*, *Sophora*, *Genista*, *Anagyris*, and *Euchresta*, with cytisine varying from 1·03 per cent in the seeds of *Ulex europaeus* Linn. to 2·06 per cent in those of *Sophora tomentosa* Linn. Only species of *Sophora* and *Euchresta* are found in India.

Cytisus scorparius Link

(Broom, Yellow Broom)

Botanical characters

A shrub 3–5 ft. high. Foliage very dark-green; lower leaves with three small obovate leaflets; upper leaves reduced to single leaflets. Flowers usually solitary in the leaf-axils, bright-yellow. Style hairy, very long and coiled. Pod $1\frac{1}{4}$ by $\frac{1}{3}$ in., smooth, but with fine long hairs down the sutures.

Distribution

A native of Western Europe; has become semi-naturalized at Ootacamund.

Medicinal and toxic aspects

The tops of this plant have been used in Western medicine, chiefly as a diuretic. These are gathered before flowering and are used while fresh or in the dried condition. No cases of poisoning are reported, but the plant merits discussion owing to the presence of certain toxic alkaloids. Consumption in large quantities of this plant is likely to produce symptoms of poisoning which, according to Waddell (*39*), consist of vomiting and purging.

Constituents

The " broom tops ", the herbaceous branches of the common broom, contain the alkaloids sparteine, sarothamnine, and genisteine (*40*). The total alkaloidal content of Scotch broom tops, calculated as pure sparteine, reached between January and June a maximum of somewhat

over 1 per cent in March, declined, and then increased slightly in June (*41*). The leaves also contain a neutral soluble phenol, scoparin (*42*).

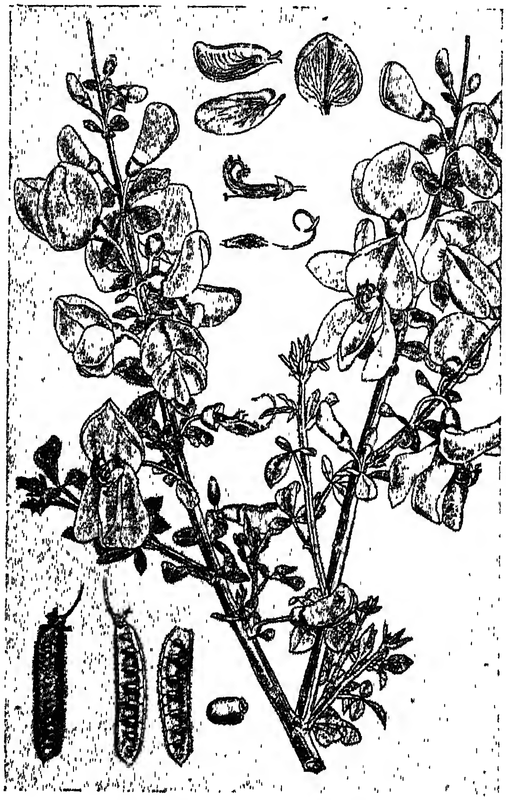

FIG. 71. *Cytisus scoparius* Link

The ripe fruits contain about 1·1 per cent of sparteine (*43*), and the seeds contain cytisine and a glucoside (*44*).

Action

Sparteine in its physiological action closely resembles coniine, the alkaloid obtained from *Conium maculatum* Linn. It appears to have little effect on the central nervous system, but paralyzes the motor nerve terminations and the sympathetic ganglia. It also causes greater depression of the heart's action than coniine, and in moderate and large doses has a depressant action on the circulation. It is poisonous but less so than coniine (*3*). It does not stimulate respiration, after the respiratory centre has been "deafferented". Under these circumstances if the drug produces any effect at all, it is one of depression. The stimulating effect of sparteine is, therefore, wholly reflex in origin (*45*). This alkaloid has been used to slow the pulse in cardiac

disturbances, but the effects are uncertain; it weakens the heart and cannot take the place of digitalis (*21*).

The physiological effects of genisteine are analogous to those of sparteine, while those of sarothamnine differ noticeably from the latter (*46*). Scoparin is a true diuretic acting on the kidney tissue proper and has a digitalis-like action on the heart muscle. The diuretic action of the broom tops, it may be noted, is due to scoparin and not to sparteine. Extracts obtained from this plant contain a substance which stimulates the heart, inhibits the intestinal movements, and dilates the bronchi and the pupils (*47*).

According to Lander (*48*), the average poisonous dose of the plant containing about 0·3 per cent of sparteine would be about 25 lbs for a horse.

12. DALBERGIA Linn. *f.*

(In honour of Nicholas *Dalberg*, a Swedish botanist, 1730–1820.)

Botanical characters

Trees or shrubs, often climbing. Leaves imparipinnate, with alternate exstipellate leaflets. Flowers copious, small, in terminal or lateral panicles. Corolla exserted; standard broad; wings oblong; keel obtuse, its petals joined at the tip. Stamens 9 or 10 monadelphous or 5+5 diadelphous, rarely 9+1. Ovary stalked, few-ovuled; style short; stigma capitate. Pod oblong or strap-shaped, thin and flat, indehiscent, not thickened or winged at the sutures, 1–4-seeded.

Distribution

Cosmopolitan in the tropics.

Dalbergia stipulacea Roxb.

Fl. Brit. Ind., II, 237.

Vernacular names: BURMA—Dank talaungnwi; LEPCHA—Ton-nyok; NEPAL—Tatebiri.

Botanical characters

A large climbing shrub, often a small erect tree. Leaf-rachis 4–6 in. long; leaflets 17–25, 1–1½ in. long, obtuse, glabrous or nearly so, moderately firm. Flowers in copious axillary panicles with elongated racemose branches; pedicels longer than the calyx; bracts and bracteoles conspicuous, persistent, oblanceolate or oblong, glabrous. Calyx ⅛ in. long; teeth as long as the tube. Corolla purplish. Stamens 5+5. Pod 2–4 by 1 in., strap-shaped, obtuse, narrowed suddenly into a stalk twice as long as the calyx, firm, glabrous, 1-seeded, thickened and veined opposite the seed.

Distribution

Found in the Eastern Himalayas up to 4,000 ft.; also in Assam, Khasia Hills, and Chittagong.

Fish poison

The bark and root of this plant are stated to be used to poison fishes (*18*).

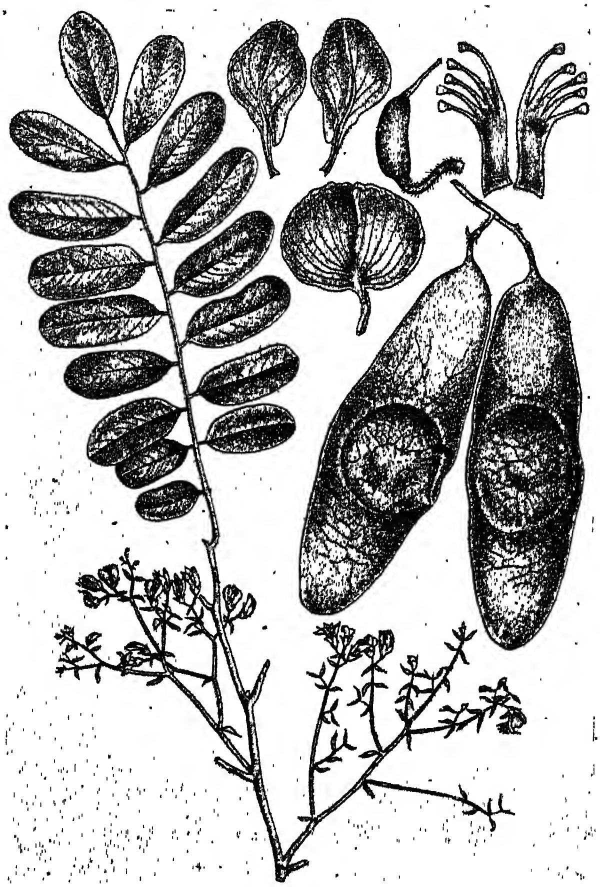

FIG. 72. *Dalbergia stipulacea* Roxb.

13. DERRIS Lour.

(From the Greek *derris*, a leather covering.)

Botanical characters

Climbing shrubs, rarely erect trees. Leaves odd-pinnate; leaflets opposite, usually exstipellate. Flowers copious, showy, usually fascicled on the rachis of axillary or terminal racemes or panicles; bracts and bracteoles small, usually caducous. Calyx campanulate, subtruncate or with short teeth. Corolla much exserted; standard broad, not auricled; wings often spurred above the long claw, somewhat adnate to the keel. Stamens usually monadelphous, but with upper filament free at base, rarely quite free; anthers versatile. Ovary sessile,

few-ovuled ; style incurved, filiform ; stigma capitate. Pod rigid, thin, flat, indehiscent, obliquely orbicular, oblong or elongate, winged on one or both sutures, 1–few-seeded.—*Derris* is in many respects closely allied to *Millettia* and, except for the greater adhesion of the wings and keel, the flowers are very similar.

Distribution

The tropics generally ; chiefly in tropical Asia.

Uses

This genus contains some fifty species, several of which are used as fish poisons. Of these, the roots of *D. elliptica* (Roxb.) Benth. and *D. malaccensis* Prain, called tuba root or aker-tuba or derris, are at present important articles of trade, since they are valuable horticultural and agricultural insecticides acting both as contact and stomach poisons. They are comparatively harmless to man and other warm-blooded animals and are, therefore, preferred to arsenicals and other mineral insecticides used as spray or for dusting purposes. They have been stated to be useful against many caterpillars, probably all larvae of leaf-eating wasps, many beetles and their larvae, turnip fleas, flower wasps, plant lice, and red spiders. They are stated to be of no value against adult flies and moths, certain kinds of caterpillars, many beetles, and scale insects. In animal husbandry they have proved very effective against the larvae of warble fly, which affect cattle and goats and cause an annual loss to India of nearly 15 millions of rupees. Tuba roots are also useful against poultry pests, such as red poultry-mite, and form the basis of some proprietary sheep dips.

An insecticidal wash effective against a wide range of pests may be made by adding 1 lb of powdered root and 4 oz of soft soap to 1 gallon of water (*49*). The powdered root, mixed with forty parts of talc, makes a very good insect powder for dogs and cats (*50*). While using tuba roots against mosquito larvae it must be remembered that they are also poisonous to fishes.

Source

D. elliptica and *D. malaccensis* are indigenous to Malaya and the East Indies ; the former is also recorded from Chittagong (*see* under *D. elliptica*). The commercial supply comes mostly from (*51*) Malaya, Sarawak, British North Borneo, and the Dutch East Indies, where the cultivation of these species has greatly increased in recent years. In the Philippines, Belgian Congo, and New Guinea, attempts are also being made to increase the production of suitable strains by cultivation. The exports (*18*) from Malaya have increased from ninety-eight tons in 1931 valued at \$53,633 to six hundred and forty-two tons in 1933 valued at \$282,795.

Constituents

Derris roots contain rotenone, deguelin, tephrosin, *iso*tephrosin toxicarol, dehydrorotenone, and other substances ; of these, rotenone is stated to be the most important constituent (*10, 52, 53*). The

amounts of these principles vary greatly in different samples of the root, and the rotenone content of the commercial samples varies from *nil* to 7 per cent of the air-dried material (*54*). Published data on the relative toxicities of rotenone, deguelin, tephrosin, and toxicarol are inapplicable for an assessment of the toxicity of derris resin, as the last three compounds do not occur as such (or, at most, in very small amounts) in derris resins. The conclusion often drawn from the published data, that the value of a derris root or resin for insecticidal purposes can only be assessed by its rotenone content, is, therefore, not wholly justified (*52*). In the commercial assay of a specimen of derris root, the total resinous content is regarded as a measure of its toxicity, irrespective of the amount of crystalline rotenone that it may contain, because the noncrystalline resin has also been proved to be as toxic as rotenone itself (*18*). Rotenone content is also not a reliable index of the toxicity of derris root when it is administered orally to warm-blooded animals (*55*, *56*).

Toxicity

Studies on the toxicity of the derris root by the method of inhalation by various laboratory animals indicate that it is much more toxic when inhaled than when administered orally, suggesting a possible health hazard to those engaged in milling, grinding, and diluting the root without the use of suitable protective measures. The probable site of the action of derris and water extracts of derris is the respiratory centre, regardless of the mode of administration (*56*). Rotenone produces respiratory paralysis, convulsions, and slowing of the heart in rabbits. In mice respiration and the heart are depressed, but convulsions seldom appear. Similar effects are obtained in frogs, and only large doses produce convulsions. In earthworms it causes a general paralysis, and in ascaris it produces a preliminary stimulation followed by paralysis. The minimum lethal dose for rabbits is 5 mgm per kgm intravenously, for mice 0·01 mgm per kgm subcutaneously, for frogs 0·5 mgm per kgm in the lymph sac, and for earthworms 0·5 per cent and for roundworms 0·1 per cent by immersion. Small doses produce an increase of rate and depth of respiratory movements in rabbits, but depression results from larger doses. It causes some dilatation of the heart and of the vessels of the lungs, spleen, liver, kidneys, mesentery, ear, and hind limbs of the rabbit. It paralyzes motor nerve endings in the frog (*57*). Rotenone, in doses of 2 to 10 mgm per kgm injected intraperitoneally, kills more than half of the animals (mammals), the lethal dose by oral administration being 75 to 100 mgm per kgm; when applied to the eye, it is more irritant than pyrethrin (*58*).

The toxicity of the constituents of derris roots and their compounds is as follows: No effects are noted when rotenone is fed to dogs in doses of 2 gm per kgm of body weight. The lethal dose has been found

to be 3 gm for rabbits, 0·6 gm for rats, and 0·06 gm for guinea pigs. Regarding the other substances, such as deguelin, toxicarol, dehydrorotenone, etc., doses as high as 1·5 gm are not fatal to rabbits and rats (*59*).

Possibilities in India

Over 20 species of *Derris* are found in India, several of these growing abundantly. There is a great possibility that some of these at least might prove to be of insecticidal value. Of the Indian species which have been investigated, *D. robusta* (Roxb. *ex* DC.) Benth. and *D. scandens* (Roxb.) Benth. were shown to be devoid of insecticidal properties, while *D. trifoliata* Lour., var. *uliginosa* (Roxb. *ex* Willd.) Badhwar (*D. uliginosa* Benth.) was examined by Tattersfield and found to possess very little insecticidal value (*51*). A specimen of *D. ferruginea* (Roxb.) Benth.* from Assam, examined by Krishna and Ghose (*51*), was found to yield a fair amount of rotenone (up to 2·4 per cent). In addition to the investigation of the various species growing wild in India, attempts should be made to cultivate the proper strains of the species of proved value, *viz.*, *D. elliptica* and *D. malaccensis.* Among the attempts so far made to cultivate tuba in different parts of India, those of the agricultural departments of Travancore, the Punjab, Kashmir and Mysore, and the Imperial Forest Research Institute, Dehra Dun, deserve notice. Roots from plants grown in Mysore State have been reported to contain 22 per cent of ether-soluble substances of which 7 to 8 per cent was rotenone, the remaining being an insecticidally active resinous substance (*61*). It may be mentioned here that observations made in Malaya on cultivated plants show that the fine lateral roots have always a higher toxic content than the larger taproots, and that the toxicity varies with the age of the plant. It is also stated that determinations of the ether extracts of the root of *D. elliptica* have shown that this plant should be harvested approximately twenty-three months after planting, when the amount of the toxic substances reaches its maximum. Thereafter the toxic principles decrease until eventually the insecticidal properties of the root become uncertain (*18*).

KEY TO THE SPECIES

A. Standard with 2 thickened callosities at the base .. .. 1. *D. elliptica.*

B. Standard with no thickened callosities at the base.

- *a.* Pod not exceeding ½ in. broad, narrowed at both ends, pubescent .. .. 2. *D. scandens.*
- *b.* Pod exceeding ½ in. broad, orbicular or oblong, glabrous .. .. 3. *D. trifoliata* var. *uliginosa.*

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* This specimen was originally identified by these authors as *D. elliptica*, but, in a recent communication published in "Current Science" (*60*), the authors state that the plant was *D. ferruginea.*

FIG. 73. *Derris elliptica* (Roxb.) Benth.

1. **Derris elliptica** (Roxb.) Benth.

Fl. Brit. Ind., II, 243.

(Ṭuba)

Botanical characters

A large, handsome climber. Stems black; shoots pubescent. Leaves 9–15 in. long; leaflets 9–13, membranous, at length sub-coriaceous, 3–6 by 1–1⅓ in., oblong to oblong-lanceolate, subacute or abruptly and often bluntly short acuminate, minutely mucronate, pubescent beneath. Racemes 9–10 in. long, tomentose. Corolla rose-pink (rarely white), ⅔ in. long; standard orbicular, back silky, base bicallose. Stamens monadelphous. Pod 1½–3½ by ⅘ in., oblong to lanceolate, 1–4-seeded, winged on the upper suture, slightly on lower.

Distribution

This plant is found in Chittagong. Krishna and Ghose reported it from Assam (*51*), but in a subsequent contribution (*60*) state that the plant in question was *D. ferruginea* (Roxb.) Benth., and not *D. elliptica*. They state " *D. elliptica* of Assam has now definitely been established as *D. ferruginea* Benth. (Kew concurring). These findings negative the occurrence of *D. elliptica* in India ". We do not know the authority on which these authors are negativing the occurrence of *D. elliptica* in all parts of India. Prain reports it from Chittagong in the " Bengal Plants ", and there are five sheets of this plant in fruiting stage in the Sibpur Herbarium, collected in May 1887 by Badul Khan (King's collector) from Kodala Hill, 30 miles from Chittagong. These bear his field no. 450, and we have no doubt that they belong to *D. elliptica*. In the " Flora of Assam ", Kanjilal, Kanjilal, and Dass mention this plant as common in the plains of Assam, and have correctly pointed out the difference between this species and *D. ferruginea*.

Toxicity

This species at present forms the chief source of the tuba root of commerce and is well known for its insecticidal and piscicidal properties which have been dealt with in detail under *Derris*. The Malays also use the bark as one of the ingredients in their ipoh arrow-poison (*19*).

2. **Derris scandens** (Roxb.) Benth.

Fl. Brit. Ind., II, 240.

Vernacular names: BENGAL—Noalata; BOMBAY—Mota-sirili; BURMA—Meekyoung-nwe, Migyaung-nwe; GOND—Golari, Nalavil, Potra; HINDI—Gonj; KANARESE—Handi-balli; MALAYALAM—Muyal-valli, Nulal-valli, Tupail; PUNJAB—Gunj; TAMIL—Anaikkattu, Kodippungu, Punalikkodi, Puliyangodi, Takil, Tegil, Tekil; TELUGU—Cheratali-badu, Chiratala-baddu, Chiratala-bodi, Chiruka-tige, Motta-sirli, Nalla-chiratala-tivva, Nalla-tige, Suruli; URIYA—Kamocho, Mohaguno.

Botanical characters

A very large climber; stem smooth, dark-purple; young parts pubescent. Leaves 3–6 in. long; leaflets opposite, 9–19, rigidly

subcoriaceous, $1\frac{1}{2}$–2 by $\frac{3}{4}$ in. (the lowest pair the smallest), elliptic-oblong or obovate-oblong, glabrous and shining above, more or less pubescent beneath.. Flowers numerous, in short-peduncled axillary racemes 10–18 in. long, arranged in fascicles from the nodes. Corolla $\frac{3}{8}$ in. long, white or pale-pink. Stamens monadelphous. Pod 1–3 by $\frac{3}{8}$–$\frac{1}{2}$ in., tapering to both ends, straight, narrowly winged on the upper suture, finely appressedly pubescent, somewhat turgid opposite the seeds, 1–4-seeded.

Distribution

Found in the forests of North Oudh, Konkan, Kanara, Madras Presidency from Northern Circars southwards, Bengal especially near Chittagong, and Orissa. Also sometimes cultivated in gardens.

Uses and properties

The bark of this plant affords a coarse rope fibre. It is used as a fish poison. McIndoo and his collaborators (*51*) found it to be devoid of insecticidal properties.

3. **Derris trifoliata** Lour., var. **uliginosa** (Roxb. *ex* Willd.) Badhwar

D. uliginosa Benth., Fl. Brit. Ind., **II**, 241, in part; *Robinia uliginosa* Roxb. *ex* Willd., Sp. Pl., 1800, **III**, 433.

Vernacular names: BENGAL—Panlata; BOMBAY—Kajarvel, Kirtana; TELUGU—Nalla-tige, Tige-kranuga; URIYA—Ketia.

Botanical characters

A large climber; branches glabrous, lenticellate. Leaves 5–8 in. long; leaflets 3–7 (usually 5), $2\frac{1}{4}$–4 by $1\frac{1}{2}$–2 in. (the terminal the largest), ovate or ovate-oblong, glabrous. Racemes axillary, 3–6 in. long, occasionally branched. Corolla $\frac{1}{4}$ in. long, rose-coloured; standard reniform, without callosities at the base. Stamens monadelphous. Pod 1–$1\frac{1}{2}$ in. long, orbicular or oblong, thin, flat, reticulately veined, shortly apiculate, glabrous, narrowly winged on the upper suture, 1-seeded.

Distribution

Found on the muddy seacoast and creeks of the Bombay and Madras Presidencies and near the sea from Cuttack tidal forests to Puri (near the Chilka Lake); also in Sundarbans and Chittagong in Bengal, and in Assam.

Toxicity

The bark of this plant is used as a fish poison. Power (*62*) examined the bark of the stem and found it to contain 9·3 per cent of tannic acid and some resins, and concluded that the toxic effects of the plant were probably due to some constituents of the resin. Krishna and Ghose (*51*), who examined the roots of this plant from the Sundarbans and Chittagong, collected during different seasons of the year, state that the "total ether extract of these roots, which is supposed to extract most of the insecticidal principles, was found to vary from 1·2 to 1·9 per cent. and although the ether solubles gave distinct colour test for

rotenone and allied bodies, no rotenone could be isolated". Tattersfield found the plant to possess very poor insecticidal properties (*51*).

14. ENTADA Adans.

(Probably from the Portuguese *dentada*—toothed, taken as *d'entada*.)

Botanical characters

Large woody unarmed climbers with tendrils. Leaves bipinnate. Flowers 5-merous, minute, in long narrow spikes, polygamous. Calyx campanulate, very shortly toothed. Petals free or slightly cohering, valvate. Stamens 10, free, exserted; anthers crested with a deciduous gland. Ovary subsessile, many-ovuled. Pod flat, woody, very large, composed of many discoid 1-seeded joints, the endocarp persistent round the large compressed orbicular seeds.

Distribution

Warm regions.

Entada pursaetha DC.

E. scandens Benth., Fl. Brit. Ind., II, 287.

(Giant's-rattle, Lady Nut, Mackay Bean, Nicker Bean, Sea Bean, Snuffbox Bean)

Vernacular names; BENGAL—Gilla, Gillo, Pangra; BOMBAY—Garambi, Garbi, Gardal, Gardul, Gharbi, Pila-papra; BURMA—Gan-nyin, Gon-nyin, Kong-nyin-nwe, Kung-nyen; HINDI—Gila; KANARESE—Dodda-ganpi, Dodda-kampi, Hallekayi-balli; KOLAMI—Karu; KONKANI—Gaer; LEPCHA—Kulhokrik, Taktokhyem; MALAYALAM—Ahakkatla, Anatata, Kakka-valli, Makkanka, Paranta, Perunkakka-valli, Vatta-valli; MARATHI—Garambi, Garbe; NEPAL—Pangra; OUDH—Gelha; PUNJAB—Kastori-kaman; SANTALI—Bidhanta; SUNDARBANS—Gila; TAMIL—Irikki, Sillu; TELUGU—Gila-tige, Pedda-madupu, Tikativva; TULU—Palleburu; UNITED PROVINCES—Chian; URIYA—Arsi, Geredi, Giridi, Osta.

Botanical characters

An immense woody climber with the 2-pinnate leaves usually ending in a point or bifid tendril; pinnae mostly only two pairs often ending in an abortive leaflet. Leaflets 2–4 pairs, narrow-elliptic to obovate, obtuse, often emarginate; terminal leaflets 2–3 in. long, others shorter towards the base of pinnae. Spikes of green or cream-coloured flowers 4–9 in. long, often extra-axillary. Pod the largest of the family in India, 1–3 ft. by 3–4 in. Seeds 1½–2 in. diam., discoid, chestnut-coloured, shining.

Distribution

Found in the Central and Eastern Himalayas up to 4,000 ft. in Sikkim; also in Eastern Bengal, Bihar and Orissa especially in damp forests situated at higher altitudes; also in the forests along the Ghats of the Bombay Presidency. In the Madras Presidency, it is found in the hill forests of the Northern Circars, the Deccan, and on the Western Ghats from South Kanara to Travancore in evergreen forests.

Uses

The beautiful seeds of this plant are largely employed for crimping linen in certain parts of India, especially in Bengal and the United

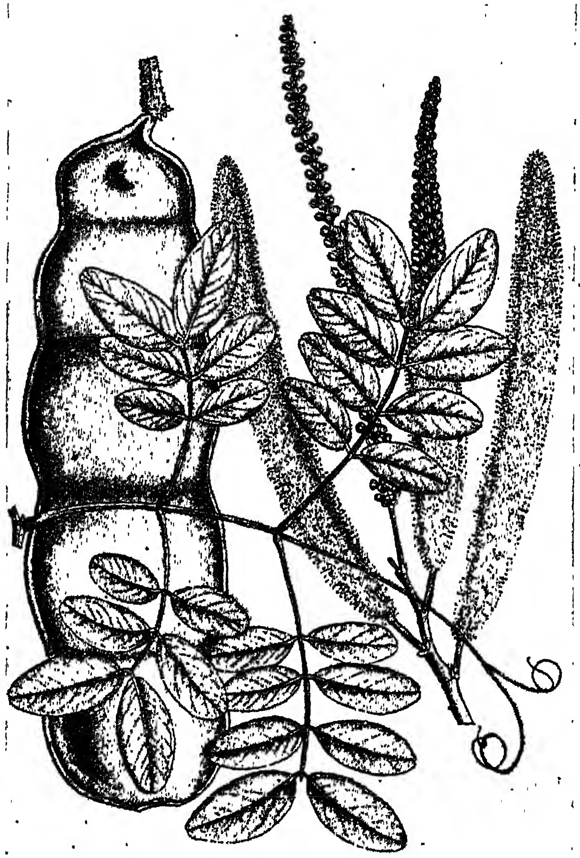

FIG. 74. *Entada pursaetha* DC.

Provinces; they are also hollowed out into boxes and other articles. They are reputed to have emetic properties, but the white kernels on being steeped in water and after roasting are sometimes eaten by local people. The authors have been informed that absence of this precaution produces deleterious effects of a narcotic nature.

Toxicity

The seeds are used as a fish poison in some parts of India, South Africa, and in the Philippine Islands, and Watt (*1*) records that "the juice of the leaves is employéd in Ceylon for stupefying fish".

Constituents

The seeds contain two toxic saponins which were biologically tested for their poisonous properties on fishes (*63*); they are also said to contain a glucoside which is hydrolyzed by emulsin (*64*).

The bark and the wood also contain toxic saponins, but these are absent in the leaves (*65*).

15. LATHYRUS (Tourn.) Linn.

(From the Greek *lathyros*, a kind of pulse.)

Botanical characters

Annual or perennial herbs. Leaves paripinnate, the rachis ending in a tendril or bristle. Flowers racemed or solitary. Calyx-tube campanulate, oblique; teeth long or upper short. Corolla more or less exserted; standard broad; keel shorter than the wings. Stamens diadelphous, the mouth of the tube not oblique. Ovary many-ovuled; style flattened at apex, bearded longitudinally on the inner (by the twisting of the style often the outer) side. Pod terete or flattish, continuous within.—Very much like *Vicia*.

Distribution

Chiefly in the North Temperate Zone.

General remarks

This genus contains about 110 species, eight of which are found in India. Of these, *L. sativus* Linn. is the most important to India since it is largely cultivated all over the country as a cold-weather crop, principally for fodder. As it is easily grown and is a cheap crop, the seeds are largely used as food by the poorer classes of people, especially in times of scarcity. The whole plant as well as the seeds, under certain circumstances, have unfortunately been incriminated in the production of poisonous symptoms or of the disease called lathyrism, both in India and in some foreign countries. This disease is characterized by degenerative changes in the spinal cord.

Numerous cases of lathyrism have been reported in literature, and the more important species which are regarded as causing the poisoning in man and animals are :—

(*i*) *L. sativus* Linn. (chickling vetch, gesse, jarosse) generally known in India as 'khesari dal', 'teora' or 'buttorah ka dal'. The peas are of two sizes—the larger kind, known as 'lakh', is grown on dry wheat-land, and the smaller, 'lakhri', is cultivated in wet rice-fields.

(*ii*) *L. cicera* Linn. This dwarf chick-pea is grown in France, Italy, and Algeria, and is used as fodder for cattle. When wheat is dear, it is used instead of flour to make bread.

(*iii*) *L. clymenum* Linn. The Spanish vetch is grown in Spain, North Africa, and the Levant.

L. tuberosus Linn. and *L. aphaca* Linn. have also been regarded as possible causes; the latter is found as a weed in India.

In view of the considerable extent to which these plants and their seeds are eaten by man and animals and the frequency with which they produce toxic effects, a detailed account of lathyrism, taken from the senior author's article in the "British Encyclopaedia of Medical Practice" (*66*), is given below. It will be seen that, besides the species of *Lathyrus*, *Vicia sativa* Linn., var. *angustifolia* Baker, which is found as a weed in cultivated ground, has also been implicated in the causation of the disease. It may also be noted that, *Lathyrus cicera*, *L. clymenum*, and *L. tuberosus* are not found in India, that very little information is available regarding *L. aphaca*, and that, despite the researches of Howard, Simonson and Anderson (*67*), holding the seeds of *L. sativus* as harmless and ascribing the poisoning to contamination by the seeds of *Vicia sativa*, var. *angustifolia*, we believe that this contamination is not universal to the extent of giving much importance to vicia in the production of naturally occurring lathyrism at least in man in India. On the other hand circumstantial as well as experimental evidence implicating *L. sativus* with the production of lathyrism in man and animals in this country and elsewhere is too strong for not accepting this plant as the cause of this disease.

LATHYRISM

History

"In India the disease has been known for centuries among the peasants. In the old Hindu literature, Bhâvaprokâsa, it is written that 'the *triputa* pulse' causes 'a man to become lame and crippled, and it irritates the nerves'. Hipprocrates mentioned that the prolonged use of certain peas as food was liable to cause paralysis. In Don's *System of Gardening* the *Lathyrus* was cited as the cause of an epidemic paralysis on the Continent in the seventeenth century. So common was the affection in 1671 that George, Duke of Württemberg, issued an edict forbidding the use of *Lathyrus*. This edict was enforced by two others in 1705 and 1714 under his successor Leopold. In the eighteenth century the disease was observed in Italy, and large numbers of persons were affected in France, Algeria, and India. Sleeman (*68*) reported an epidemic outbreak in the Saugor district of the Central Provinces in 1833–4. Irving (*69*) contributed a series of valuable papers (1859–68) on outbreaks in the United Provinces. An extensive epidemic was recorded by Andrew Buchanan (1904) (*70*) in the Central Provinces when about 7,600 persons were affected. Acton (1922) (*71*) estimated that in North Rewa there were 60,000 victims or 6 per cent of the inhabitants. McCombie Young (1927) (*72*) reported that in some areas as many as 13 per cent of the adult male population and 3 per cent of the adult female population were affected.

Geographical incidence

"Lathyrism occurs in those districts in which vetches, *Lathyrus sativus* and allied species, form the main article of diet. In India the disease is most prevalent and is commonly met with in the Central Provinces, North Bihar, and some districts in the United Provinces, although outbreaks are not unknown in Sind and Chota Nagpur. It also occurs to a lesser extent in France, Italy, Algeria, Abyssinia, and Persia.

Lathyrus peas as food

"The *Lathyrus* peas yield a cheap food, the consumption of which is liable to produce the disease. The plants are hardy and grow well even during famine years. They therefore constitute the bulk, if not the whole, of the diet at such times, and it is then that lathyrism becomes prevalent. Apart from famines, large agricultural populations in some parts of India subsist to a great extent on *Lathyrus* peas, such as *khesari*, *teora*, and *matra*. These peas are used in several ways; they may be ground into flour and eaten raw; the flour may be made up in hand-made bread or *chappaties*. The vetch is also boiled in water with salt, and the thick pea-soup, known as *dal*, is eaten with rice or bread. During times of famine and drought it almost completely supersedes all other articles of food, including even rice and vegetables.

Susceptibility of animals

"*Lathyrus* is also used as food for domestic cattle which, like human beings, are liable to lathyrism. Horses are particularly susceptible and often have died after eating *khesari dal*. Elephants and monkeys are also known to be affected.

Responsible factor

"There is little doubt that there is an intimate relation between the ingestion of *L. sativus* as food and the occurrence of lathyrism in man. The exact factor responsible for its production is not yet understood. Stockman (1917) (*73*) and Dilling (1920) (*74*) extracted from the seeds of *L. sativus* minute quantities of an alkaloidal substance, with which they inoculated animals and produced symptoms resembling those of lathyrism. Acton and Chopra (1922) (*75*) found in the seeds a toxin of the nature of a water-soluble amine, and produced symptoms resembling those of lathyrism in ducks and monkeys by injection of the soluble amine. Acton suggested that this toxic amine was produced in *L. sativus* during germination, and that this accounted for the high incidence of the disease during the rainy season of the year, July, August, and September. The results of animal experiments recorded by different observers have been conflicting. The discrepancy is mainly due to the fact that there is very commonly a contamination by the seeds of various weeds in the samples of *Lathyrus*.

"Howard, Simonsen, and Anderson (*67*) elaborately studied the subject. They showed that samples of *khesari*, collected from many parts of India where lathyrism was prevalent, contained, apart from

Lathyrus sativus, various weeds which contaminated the true *khesari*. Feeding experiments on animals showed that the pure grain formed a harmless and nourishing food, and chemical investigation of numerous samples of botanically pure *khesari* failed to demonstrate the presence in the seed of bases of an alkaloidal nature. They showed that a vetch known as *akta*, *Vicia sativa* Linn. var. *angustifolia*, was present in all the samples of *L. sativus*. Chemical investigation of *akta* demonstrated the presence of....vicine and divicine, and a cyanogenetic glucoside vicianin....Definite signs of poisoning with involvement of the central nervous system could be obtained with divicine in laboratory animals, such as guinea-pigs. Vicine is apparently non-toxic but by hydrolysis may become the toxic divicine; this can readily occur during gastric digestion.

" Although some of the symptoms in monkeys fed on diets containing *akta* are suggestive, there is still insufficient evidence to connect lathyrism in man with the ingestion of *akta*. McCombie Young pointed out that some other factor was responsible besides the mere presence of *L. sativus* in the diet, and he was inclined to believe that lathyrism might be to some extent a deficiency disease. Degenerative changes occur in the spinal cord of dogs fed on diets deficient in vitamin A. It is possible that the absence of vitamin A from the diet allows the neurotoxin in the peas to exert its harmful effects on the central nervous system. Stockman (1934) (*76*) reported that a watery extract of *Lathyrus* peas contained salts of phytic acid, which exerted a marked action on the brain and spinal cord. Moderate doses produced torpor and depression and larger doses clonic and tonic spasms. Feeding with large quantities of *Lathyrus* peas and the injection of the salts isolated from them caused degeneration of nerve-cells and nerve-fibres of the cerebrospinal and sympathetic systems. Stott, on the other hand, could not produce toxic symptoms in horses by prolonged feeding of pure cultures of either *L. sativus* or *Vicia sativa*.

Clinical picture

" The symptoms vary according to the quantity of *khesari* consumed daily and the period of time during which it was eaten. The onset is usually dramatically sudden. It occurs abruptly after the individual has been living on *Lathyrus* for two to five months. In a few cases the onset is insidious, and prodromal symptoms, such as fever, chills, backache, burning pains, cramps, and tingling or pins and needles in the legs, may have been noticed. Such cases, however, are few. Very often the disease follows over-exertion or exposure to cold or rain, the victim finding the legs and loins weak and heavy. A typical history is that a patient has had a heavy day's ploughing and has taken shelter under a tree, and then finds that he is unable to walk and has to be

carried home. Or he is at work in the field when he is seized with a rigor and fever; he goes home to bed for a few days, and on getting up he finds he cannot walk properly. The muscles become tremulous when weight is put on them; there is dragging of the legs with inability to walk. Weakness and stiffness of the legs rapidly become more severe, reaching a maximum in a few days. After this there may be some symptomatic improvement, but the paresis persists indefinitely. Generally the sphincters are not affected, but occasionally there may be incontinence of urine and faeces. The sexual power is said to be enfeebled, but the mind, speech, and pupils escape. The affected muscles are in most cases not wasted, and sensation is generally normal. In a few cases the arms have been affected in the same way as the legs. Convulsive movements of the extremities and muscular wasting have been observed.

"The physical signs are those of typical spastic paraplegia. The knee- and ankle-jerks are exaggerated, with ankle and patellar clonus and extensor plantar response. The characteristic gait depends on the degree of involvement of the spinal tracts; at first the attitude of the legs is one of extension with adduction, the patient walking on tiptoe; the body is raised high before the toes leave the ground, giving rise to up and down movement of the shoulders, and progression is effected by tilting the pelvis and circumducting the legs. The legs are crossed scissors-wise. The more feeble patients use one or two long sticks for support in walking. Later paraplegia in flexion develops, and in the final stages walking is impossible. Progression is made by crawling on the balls of the toes and on the hands, which are often supported on wooden sandals...... In most cases the trunk and upper limbs are unaffected, and the chest and arm muscles are usually well developed owing to the extra work put upon them. The cerebrospinal fluid was found by Trabaud and others to contain an excess of protein with a normal cell count.

Course and prognosis

"The disease runs a very chronic course. Degeneration limited to the motor tract is not a direct danger to life. The degeneration may be arrested, but there is not any possibility of cure in the sense of restoration to the previous condition of health.

Prevention and treatment

"Prevention of the disease depends on the improvement of the economic condition of the poor agricultural population of India. Howard and his associates suggested that *khesari dal* should be planted in drills and the contaminating *Vicia sativa* removed by weeding. This should be done not only in places where lathyrism is rife but also in areas from which grain is sent to the famine-stricken areas. In view

of the divergent views on the part played by *Vicia* in the spread of the disease successful measures cannot yet be devised.

"No specific remedy for lathyrism is known. The consumption of *khesari dal* must be discontinued, and exposure to chills and wet should be avoided. Massage and electrical treatment are sometimes helpful. The patient should be properly nourished. Mellanby (1934) has suggested the use of vitamin A. It is always desirable to see that the diet is generous and rich in available proteins and vitamins."

KEY TO THE SPECIES

a. Leaflets abortive. Flowers yellow. Pod wingless .. .. 1. *L. aphaca*.
b. Leaflets 2 or 4. Flowers red, bluish or white. Pod dorsally 2 winged .. .. 2. *L. sativus*.

1. Lathyrus aphaca Linn.

Fl. Brit. Ind., II, 179

(Yellow Vetchling)

Vernacular names: BENGAL—Jangli-matar, Musur-chana; HINDI—Jangli-matar; NEPAL—Kaibu; PUNJAB—Gagla, Rawari.

Botanical characters An annual herb with slender wingless much-branched stems. Leaves altogether reduced to tendrils at the base of which are the large, hastate, truncate, leaf-like stipules. Flowers 1–2 on a long axillary stalk, yellow. Pod 1 in., wingless, 4–6 seeded.

Distribution Found in the North-West Frontier Province, the Punjab, the United Provinces, Bengal, and Central India, ascending to an altitude of 7,000 ft. on the Western Himalayas.

Uses and properties This plant is used in many localities as fodder for cattle. According to Voigt, the ripe seeds are narcotic, their effect being noticeable when eaten abundantly; in the young state, however, they are perfectly harmless (*1*). The plant has been regarded as one of the possible causes of lathyrism.

Constituents According to Pammel (*2*), the plant contains hydrocyanic acid, but the authors have not found any original reference for this statement.

2. Lathyrus sativus Linn.

Fl. Brit. Ind., II, 179.

(Chickling Vetch, Gesse, Jarosse)

Vernacular names: BENGAL—Kassur, Khesari, Teora; GUJERATI—Lang, Langue; HINDI—Kansari, Kasari, Kassar, Kassur, Khesari, Latri, Tiuri; MARATHI—Lakh; MUNDARI—Kansari, Kesari; NEPAL—Kesari; PERSIAN—Masang; PUNJAB—Chural, Karas, Karil, Kisari, Mattar; SANSKRIT—Lanka,

Sandika, Triputa, Triputi; Santali—Kesari; Sind—Mattar; United Provinces—Chapa, Chural, Kasa, Kisara, Latri, Mattar, Tiura; Uriya—Chana.

Botanical characters

A pretty annual with winged stems. Leaves ending in 2- or 3-fid tendrils; stipules semi-sagittate; leaflets 2 or 4, 1–2½ in. long, linear-

Fig. 75 *Lathyrus sativus* Linn.

lanceolate, acuminate. Flowers solitary, axillary, ¾ in. long, red, bluish or white. Pod 1½ in. long, dorsally 2-winged, 4–5-seeded.

Distribution

Largely cultivated in many parts of India up to an altitude of 4,000 ft. in the Himalayas.

Uses and properties

This plant is largely used as fodder, and being cheap the seeds are considerably used as food by the poorer classes of people, especially

in times of famine. The seeds as well as the whole plant produce lathyrism in man and animals under certain circumstances. The chemistry of the plant as well as the symptomatology of this disease have been fully discussed under *Lathyrus*.

The seeds are said to contain about 1 per cent of a powerful and dangerously cathartic oil (*1*).

LUPINUS (Tourn.) Linn.

(From *lupus*—a wolf; in allusion to its destroying or exhausting land.)

(Lupines)

Uses and properties

The harmful effects produced by several species of *Lupinus*, which have been and are still used in foreign countries as food and fodder, are extensively referred to in the literature on this subject. All parts (leaves, pods, and seeds) of these plants are toxic, and it appears that their toxicity may vary considerably in different species, at different times, and in different areas. The leaves are stated to be less toxic than the pods, and the pods much less so than the seeds. According to Lander (*48*), of the lupines only *Lupinus luteus* Linn. or the yellow lupine appears to be very dangerous on the Continent, but in Montana (U. S. A.) *L. leucophyllus* Dougl. *ex* Lindl. plays an important part in producing poisoning. Heaviest losses are reported to have occurred amongst sheep, but all domestic and laboratory animals are susceptible to lupine poisoning.

Constituents

Steyn (*5*) differentiates lupinosis into two forms: (*A*) an American and (*B*) a European variety. With regard to the American lupinosis, different species of *Lupinus* contain different alkaloids, such as l-sparteine (lupinidine), lupinine, lupanine (d-, l-, and dl-), hydroxylupanine, spathulatine, monolupine, etc.; of these d-lupanine is considered to be the most toxic. The European lupinosis is said to be due to the presence of "ictrogen" or "lupinotoxin", a substance related to bacterial toxins. European lupines also contain alkaloids similar to those present in the American plants.

European lupinosis

Continual feeding on certain quantities of lupines in Europe produces a chronic form of lupinosis which is characterized by the development of anaemia, cachexia, exanthemata on the head, catarrh of the nasal mucous membrane and conjunctiva, and ascites. Icterus is very rare. *Post-mortem* examination reveals an atrophic chronic interstitial hepatitis. In acute form, the symptoms and *post-mortem* appearance of European lupinosis markedly resemble those seen in phosphorus poisoning. Inappetence, fever, accelerated pulse, general icterus, depression, cerebral excitement, coma, paralysis, trismus, dyspnoea, constipation, and later haemorrhagic diarrhoea may be found in affected animals. In horses, necrosis of the skin and ulceration of the buccal and nasal mucous membrane are described. Bloody urine, containing bile-pigments and albumen, and swellings of the ears, eyelids, lips, and nose were seen in lupinosis in Europe (*5*).

American lupinosis

The American lupinosis differs from that occurring in Europe, in so far as fever and jaundice are concerned. These are characteristic of the disease in Europe but are not encountered in America. In the case of American lupinosis, Steyn describes the following symptoms in sheep: Frothing at the mouth; severe attacks of dyspnoea (the animals sometimes die in convulsions during these attacks); coma, which may progress until the animal dies; continual pushing of the head against stationary objects; swinging of the head rythmically from side to side; frenzy; accelerated pulse; staggering and falling; violent trembling; nausea; and bloating, especially when lupine leaves are eaten. The period between feeding and the appearance of symptoms may vary from one to twenty-four hours (*5*).

Prevention

Lupine poisoning can be prevented by (*a*) giving small quantities (not more than one tenth of the total feed) intermittently, (*b*) soaking the seed in a 1 per cent sodium-carbonate solution for a couple of days, and discarding the solution, or (*c*) steaming the plant or its seeds at a pressure of two atmospheres (*5*).

16. MELILOTUS Tourn. *ex* Hall.

(From the Greek *meli*—honey, and *lotos*—lotus ; the flowers are much visited by bees.)

Botanical characters

Herbs. Leaves pinnately 3-foliolate; leaflets toothed; stipules adnate to the petiole. Flowers small, yellow or white, in long slender axillary racemes. Calyx-teeth 5, subequal. Corolla free from the staminal tube, caducous; standard and wings narrow; keel straight, obtuse. Stamens diadelphous. Ovary few-ovuled; style much incurved, glabrous. Pod short, subglobose or oblong, exserted, indehiscent or tardily dehiscent; 1- or few-seeded.

Distribution

Temperate and subtropical regions.

Indian species of Melilotus

This genus consists of twenty species of which three are found in India. These are: (*a*) *M. alba* Desr., the white-flowered sweet clover found in the plains of Northern India up to an altitude of 12,000 ft.; (*b*) *M. indica* (Linn.) All. (*M. parviflora* Desf.), the pale-yellow-flowered sweet clover found in the tropical zone of India, cultivated as fodder or as a cold-season weed of cultivation; and (*c*) *M. officinalis* Lam., the yellow-flowered sweet clover found in Nubra and Ladakh at altitudes of 10,000 to 13,000 ft.—it is cultivated in Europe as fodder.

Uses and properties

The above-mentioned species are considered valuable fodder for livestock either in the green condition or when made into hay.

Ewart (*77*) writes the following in regard to the toxicity of melilot (*Melilotus* sp.): " All the species contain cumarin, a volatile odoriferous principle, which in excess produces a disinclination to locomotion, paralysis, and ultimately fatal symptoms. No harm is to be apprehended if the amount present does not exceed 10 per cent. of the herbage ". Millspaugh, quoted by Pammel (*2*), states that in " large doses, *cumarin* causes nausea, vomiting, vertigo, great depression of the heart's action, and cold extremities ". According to Gunn (*78*), cumarin " is a powerful narcotic, but very irritating to the stomach ". When administered internally to dogs in doses of 7 to 10 grains it produces great and even fatal depression, and in man doses of 30 to 60 grains produce nausea, giddiness, depression, vomiting, and drowsiness (*1*).

According to Watt (*1*), *M. alba* has been known to produce colic in cattle, " but all plants, especially of the clover kind, if eaten in excess in the green state, are liable to cause this complaint ". Marsh and Roe (*79*) fed the seeds (consisting mainly of immature seeds) of this plant to sheep and concluded that (*a*) " sweet clover screenings are not poisonous " and (*b*) " sweet clover screenings can be fed to sheep with hay to advantage ".

Fröhner (*80*) reports that according to Correy and Collas the seeds of *M. officinalis* are poisonous. Horses which received "2–3 litres of the seed" daily developed paralysis of the body musculature, death occurring after ten to twelve days. Autopsy revealed pronounced hyperaemia of the lungs and swelling of the liver. Fröhner does not agree with the view that cumarin is the cause of poisoning.

Pammel (*2*) records that *M. indica* is said to cause paralysis.

Steyn (*5*) reviews recent literature regarding the "sweet-clover" disease in cattle, and the following account is taken from his "Toxicology of Plants in South Africa".

"Schofield (1924) (*81*), Hadley (1926) (*82*), Roderick (1929, 1931) (*83*), Roderick and Schalk (1931) (*84*), and Schalk (1929) (*85*) refer to 'sweet clover' disease in cattle. Roderick and Schalk have proved that the feeding of 'damaged sweet clover' to cattle and rabbits may result in death from haemorrhage. The first recognisable change in an animal fed on 'damaged sweet clover hay' is a delay in the coagulation time of the blood. This delay progresses when the feeding of the damaged hay is continued. Swellings, which represent extravasations of blood, may appear all over the body and may result in stiffness and lameness. The visible mucous membranes are pale. Profuse haemorrhage may occur from small superficial wounds, or during surgical operations (dehorning, castration). Ataxy, inability to rise, and loss of sensibility point to haemorrhage in the nervous system. Furthermore, haemorrhage may occur in all organs. Death, which is preceded by progressive weakness, is due to excessive haemorrhage.

"The delay in coagulation time in cattle usually sets in from the third week after commencement of feeding 'damaged sweet clover hay' and haemorrhage was encountered from the nineteenth to the fifty-third day of feeding. Young cattle are more susceptible than full-grown animals. Rabbits fed on 'damaged sweet clover hay' developed symptoms similar to those seen in cattle.

"The delay in coagulation time of blood was found to be due to a decrease in the prothrombin constituent and is not dependent upon the number of blood platelets present. Anaemia is due to haemorrhage, cellular destruction, and damage to the haematopoietic tissues. There is no deficiency of calcium in the blood.

"Roderick and Schalk (1931) (*84*) have failed to extract the toxic principle of damaged sweet clover. They consider *cumarin* as an unlikely cause of sweet clover disease. They recommend that the effects of suspected sweet clover hay be tested on rabbits before being fed to cattle and that cattle should not be operated on, castrated, or dehorned

until at least three weeks have elapsed since feeding of suspicious sweet clover hay.

Treatment

"No commercial haemostatic agent is of any value. Intravenous injection of 750–1,500 c.c. of defibrinated normal bovine blood is of life-saving value in the treatment of sweet clover haemorrhage. The use of horse blood for this purpose is not recommended as it appears to be dangerous".

17. MILLETTIA Wight & Arn.*

(In honour of J. A. *Millett*, a French botanist of the eighteenth century.)

Botanical characters

Trees or shrubs, usually climbing. Leaves imparipinnate; leaflets opposite, penninerved, usually stipellate. Flowers usually showy, in axillary, often fascicled racemes, or racemes panicled and terminal. Calyx campanulate; teeth short or 0. Corolla much exserted; petals with long claws; standard broad; keel not beaked. Stamens monadelphous or diadelphous; filaments filiform; anthers uniform. Style filiform, incurved, glabrous; stigma capitate. Pod linear or oblong, flat or turgid, coriaceous or woody, late in dehiscing or hardly dehiscent, 1- or few-seeded.—Species of *Millettia* closely resemble those of *Derris* when in flower. The anthers in the latter genus are, however, versatile and the stipellae almost always absent.

Distribution

Tropics of the Old World.

Toxicity

This genus contains 70 species of which about a dozen are found in India. The roots of some of the species are known to be poisonous to fishes and at least two of these (*viz.*, *M. taiwaniana* Hayata of Formosa and *M. pachycarpa* Benth. of India) are said to contain rotenone, which is one of the important insecticidal principles of *Derris*. Of the species found in India, only two are known to be poisonous to fishes and both of these have also insecticidal properties. There is little doubt, however, that on investigation some more will be found to have these properties. *M. piscidia* Wight & Arn. from Sikkim and Assam, as the name suggests, is very likely to be poisonous to fishes.

KEY TO THE SPECIES

a. Standard auricled at the base on both sides of the claw .. 1. *M. auriculata*.
b. Standard not auricled at the base . .. 2. *M. pachycarpa*.

* The roots of a representative of a closely allied genus, *viz.*, *Whitfordiodendron pubescens* (Craib) Burkill (*Millettia atropurpurea* Baker, in part, *non* Benth.) of the Malay Peninsula and Tenasserim, are noted for their piscicidal properties; the seeds of this plant contain a poisonous glucoside, the chemical and toxicological properties of which closely resemble those of saponins (*10*).

1. **Millettia auriculata** Baker *ex* Brand.

Fl. Brit. Ind., II, 108.

Vernacular names: BURMA—Wunu; GOND—Gurur; HALDWANI—Goj; HINDI—Gaj, Ganj, Gauj; KOLAMI—Hel; KUMAON—Ganj, Gauj, Gauja, Gonjha; LEPCHA—Brurik, Tarorrik; MALAYALAM—Valli-muritali; MUNDARI—Haranari, Helaranari, Helharanari; NEPAL—Gonjo; OUDH—Mandh; SANTAL—Hehel; TELUGU—Kondatangedutige; THARU—Ganj, Gora; URIYA—Arkawla, Kissi, Rekorlo.

Botanical characters

A large robust woody climber with finely downy branchlets, often seen as a suberect shrub. Leaves 1–2 ft. long; leaflets 7–9, 3–8 in. long, obovate, obtuse or cuspidate, thinly silky beneath. Flowers $\frac{2}{5}$–$\frac{1}{2}$ in., cream-coloured, fascicled on numerous racemes 4–9 in. long, which are often clustered on short stout axillary peduncles. Standard auricled at base on both sides of the claw. Stamens monadelphous. Pod 4–7 by about 1 in., flattened, woody, brown-velvety, sutures thickened.

Distribution

Commonly met with in the Outer Himalayas from the Sutlej eastwards to Sikkim, ascending to altitudes of 3,500 ft. Abundant in the forest tracts of Dehra Dun, the Siwalik Range, Rohilkhand, North Oudh, Gorakhpur, and Bundelkhand. Also found in Bihar and Orissa, Bengal, and the forests of Ganjam and Vizagapatam up to 4,000 ft.

Toxicity

The root is applied to sores in cattle in order to kill vermin. It is also used to poison fishes (*1*).

2. **Millettia pachycarpa** Benth.

Fl. Brit. Ind., II, 106.

Vernacular names: BENGAL—Bishloti; NEPAL—Kakush-bish, Kurkus

Botanical characters

A large climber, with the branches and leaves below more or less densely clothed with pale-brown pubescence. Leaves 1 ft. or more long; leaflets 11–13, 3–8 in. long, oblanceolate-oblong, abruptly acuminate, exstipellate, subcoriaceous, opaque above, the pubescence below short, loose, deciduous. Racemes copious, 6–9 in. long. Calyx densely downy. Corolla $\frac{3}{4}$–1 in. long; standard glabrous on the back, not auricled at the base. Stamens monadelphous. Pod up to 4–5 in. long, 1–1$\frac{1}{4}$ in. broad, woody, rugose, glabrous, 1–3-seeded.

Distribution

Found in the forests of Garo and Khasia Hills, Sikkim, and Assam up to an altitude of 4,000 ft.

Toxicity

The plant is commonly known as fish-poisoning vine in China, the root being commonly used for this purpose.

It contains a large amount of saponin and possibly also considerable quantities of rotenone, one of the active insecticidal principles of *Derris*. Mixture of this plant with soap or tea oil serve not only as

good insecticides, but also as contact and stomach poisons, the efficiency for the latter purposes being not inferior to that of *Derris* (*86*).

FIG. 76. *Millettia pachycarpa* Benth.

18. MUNDULEA (DC.) Benth.

(From *mundulus*, diminutive of *mundus*—cleanly ; suggested by the clean style.)

Botanical characters

Shrubs or small trees, usually silky-pubescent. Leaves imparipinnate. Flowers in terminal racemes, the pedicels fascicled. Calyx campanulate ; teeth short, the 2 upper often subconnate. Corolla much exserted ; standard large, long-clawed ; wings falcate-oblong ; keel incurved and obtuse at the apex. Stamens monadelphous ; alternate filaments slightly dilated. Ovary many-ovuled ; style filiform, glabrous, much incurved. Pod large, linear, subindehiscent, sutures thickened.

Distribution

Tropical Africa, Madagascar, Ceylon, Western and Southern Indiai

Toxicity

This genus contains about 20 species most of which are employed to stupefy fish. Only one species discussed below is found in India.

Mundulea sericea (Willd.) Greenway

M. suberosa Benth., Fl. Brit. Ind., **II,** 110.

Vernacular names: BOMBAY—Supti; DECCAN—Supti, Surti; KANARESE—Betta-huruli, Kadu-betta-huruli, Kadu-tuvari, Menbundati; MALAYALAM—Kat-tu-tuvara; TAMIL—Kadu-porasu, Pilavaram, Piralavaram, Vellai-porasu; TELUGU—Konda-vempali, Palasaram, Palasara-patti, Vetti-billudu.

Botanical characters

A stout shrub or a small tree 10–15 ft. high; branches sericeous. Leaflets 17–23, $\frac{1}{2}$–$1\frac{1}{3}$ by $\frac{1}{4}$–$\frac{5}{8}$ in., coriaceous, oblong-lanceolate, obtuse or

FIG. 77. *Mundulea sericea* (Willd.) Greenway

subacute, glabrous and bright-green above, silvery-silky beneath. Flowers in close terminal racemes. Calyx silky-hairy. Corolla $\frac{3}{4}$–1 in.

long, pinkish-violet; standard silky outside. Pod 3–4 in long, flattened, densely velvety with short golden-brown hairs, thickened at the sutures, 3–8-seeded.

Distribution

Found in Western and Southern India in Konkan, the Circars, the Deccan, and Carnatic to Tinnevelly, in dry forests on rocky hills up to 4,000 ft.

Toxicity

The seeds of this plant are used for poisoning fish in Southern and Western India; the bark also possesses piscicidal properties. According to Greenway (*87*), the plant is stated to be poisonous to crocodiles and to have the effect of driving them away from the river. He also states that the people of Tanganyika sometimes tie the strips of bark round the legs of the cattle, when they are taken to the river to water, to protect them from these reptiles. It is very likely that the root is also poisonous to fish. According to Pammel (*2*), the bark and the root contain a very toxic glucoside, but we have not been able to verify this statement. The bark is reported to contain only 0·8 to 0·9 per cent of rotenone, but is stated to be almost as toxic to various insects as the root of *Derris elliptica* (Roxb.) Benth. (*88*). The activity of the bark is not affected by heating to 100°C., by storage for long periods in closed containers or by desiccation over mineral acids.

19. OUGEINIA Benth.

(From *Ujjain*, a town in Central India whence seeds of *O. dalbergioides* Benth. were sent in 1795 to Roxburgh at the Calcutta Royal Botanic Gardens.)

Botanical characters

A tree, with pinnately 3-foliolate, stipellate leaves. Flowers in fascicled racemes in leaf-axils and on old wood. Calyx-tube campanulate; teeth small, upper 2 subconnate. Corolla exserted; standard broad; keel obtuse. Stamens diadelphous. Ovary many-ovuled; style incurved, subulate; stigma capitate. Pod linear, flat, smooth, formed of 2–5 large, more or less distinct, scarcely dehiscent joints.

Distribution

A single species, confined to India.

Ougeinia dalbergioides Benth.*

Fl. Brit. Ind., II, 161.

(Chariot Tree)

Vernacular names: BANSWARA—Tunnia; BENGAL—Tinis; BHIL—Tewsa; BOMBAY—Sandan, Telas, Timas, Timsa, Tivas, Tunaj, Tunnia, Tunus; CENTRAL PROVINCES—Kala-phalas, Kari-mattal, Tinnas, Tinsa; GOND—Ser,

* Some authors prefer to call it *Ougeinia oojeinensis* Hochr., but this name offends against the International Rules of Botanical Nomenclature.

Prevention

The cultivated beans, preferably the white ones, should be used. The danger of poisoning with the beans containing dangerous amounts of phaseolunatin can be materially reduced by thoroughly boiling and discarding the water, or by steaming the beans, in order to destroy the enzyme which is responsible for the liberation of hydrocyanic acid. It may be remembered, however, that the hydrochloric acid present in the stomach can also liberate hydrocyanic acid. It is dangerous to allow the beans to soak in water overnight before they are fed or eaten, as the practice facilitates the liberation of fatal quantities of hydrocyanic acid, in case dangerous amounts of phaseolunatin are present in them. Also, the boiled beans if allowed to stand for a long time before consumption may develop hydrocyanic acid through the action of bacteria on phaseolunatin (*5*).

PHYSOSTIGMA Balf.

(From the Greek *physa*—a bladder, and *stigma*—a spot, a mark.)

Physostigma venenosum Balf.

(Calabar Bean, Ordeal Bean)

Uses and properties

This plant is a climbing perennial of tropical Western Africa, and its seeds have long been employed by the natives as an ordeal poison. They are highly poisonous, and a case is on record when a dose of twelve grains taken for the purpose of an experiment produced alarming symptoms in an adult. Cases of accidental poisoning have also been reported. The plant does not grow in India, but its medicinal preparations are imported into this country for use in ophthalmic practice to contract the pupil, and also lately in the treatment of myasthenia gravis. On account of its marked toxicity, however, its internal use is limited.

Constituents

The seeds contain the alkaloids physostigmine (eserine), geneserine, eseramine, *iso*physostigmine, eseridine, and physovenine; of these, physostigmine is the most important.

Action

Physostigmine is one of the parasympathetic poisons and acts upon the terminations of these nerves in the same way as muscarine and pilocarpine. Hunt (*94*) found that it had a sensitizing effect on the actions of acetyl-choline, and later Loewi (*95*) showed that minute amounts of physostigmine inhibited the activity of the specific esterase which inactivates acetyl-choline. The peripheral action of physostigmine is, therefore, partly indirect, due to its prolonging the action of acetyl-choline liberated at the nerve ends, and possibly it may be found that all its actions are thus mediately produced.

Physostigmine paralyzes the central nervous system, and death ensues from respiratory failure. In certain species of animals the paralysis is preceded by great excitement with anxiety and desire for movement. These symptoms may be due partly to the accompanying dyspnoea and changes occurring in the circulation.

Among the peripheral organs that are especially affected by physostigmine the eye may be mentioned first. Shortly after the appearance of myosis, the ciliary muscles contract but relax more quickly than the iris, so that the accommodation paralysis lasts only for a couple of hours. The intraocular tension at first increases a little, but then falls below normal, no doubt on account of the vasoconstriction.

Many other organs both with smooth and striated muscles are affected. In warm-blooded animals, widespread fibrillary twitchings in the skeletal muscles are seen during poisoning. The entire gastro-intestinal canal is thrown into a state of contraction; there is vomiting and diarrhoea which is at first faecal in character, but later becomes watery and mucoid.

Like muscarine and pilocarpine, physostigmine causes increased secretion from several glands, especially the salivary glands.

Symptoms

The symptoms of poisoning vary but little in different animals; in dog and rabbit, the first effect of a large dose of physostigmine is weakness in the voluntary movements and a curious tremor and muscular twitching, beginning in the hind legs, but soon extending over the whole body. The animal falls on one side and cannot raise itself again. The saliva and tears are increased, the bowels are often evacuated, and in dog vomiting is common. The respiration is at first rapid and deep, and later slow and dyspnoeic; the heart is weak and slow, and the pupils are contracted to a small point. These symptoms become more marked as more of the poison reaches the blood, until respiration ceases. In cat, the symptoms are the same except that they are preceded by a stage of increased movement and evident anxiety. In man, physostigmine produces practically the same effects as in dog, there being vomiting, pain in the stomach region, dyspnoea, giddiness, muscular weakness, contraction of the pupil, salivation, and perspiration. The heart is slowed, muscular twitchings may be present, followed by collapse. In frog, the voluntary movements disappear soon after the injection of physostigmine, the respiration ceases, and the reflexes are finally paralyzed.

The secretions are increased by physostigmine in the same way as by pilocarpine and muscarine; the saliva, tears, perspiration, mucus, and the pancreatic juice are all augmented.

Physostigmine produces powerful contractions of the stomach, intestines, ureter, bladder, spleen, and bronchial muscle, resembling those elicited by muscarine and pilocarpine.

Post-mortem appearance

The large intestines are empty, pale, wrinkled, and hard; the bladder is empty and contracted as also is the uterus. The muscles and motor nerves retain sensibility for some time after death (*48*).

Treatment

The treatment consists in giving emetics or using the stomach pump. After respiratory failure, life may be prolonged or even saved by prolonged artificial respiration —Kaufmann (*48*). Atropine is antagonistic to physostigmine and should be given subcutaneously, but large doses should be avoided as they may act in a synergistic manner. Alcohol, digitalis, and ammonia may be given by mouth, while strychnine is a good stimulant for the respiratory centres.

21. PITHECELLOBIUM Mart.

(From the Greek *pithekos*—ape, and *lobion*—a lobe.)

Botanical characters

Closely allied to *Albizzia*, but sometimes spinescent. It differs chiefly in the compressed pod being circinate or spirally twisted, coriaceous or fleshy and dehiscent, and the seeds often arillate or embedded in pulp.

Distribution

Tropics.

Pithecellobium bigeminum Mart.

Pithecolobium bigeminum Benth., Fl. Brit. Ind., II, 303.

(Soapbark Tree)

Vernacular names: BURMA—Danyinthi, Dhayinthi, Tanyen, Tanyenthi; HINDI—Kachlora; KANARESE—Kadakonde, Kankarinje, Nuggikar; LEPCHA—Tikpikung; MALAYALAM—Attapparanta, Kal-pakku, Kaunatti, Kattukonna, Mutha-kolappan, Mutta-koluppan, Pannivaka, Varikiri; SANSKRIT—Aragvadha; TAMIL—Kalai-pakku, Kal-pakku; TULU—Kakke.

Botanical characters

A middle-sized unarmed tree; young parts glabrous or slightly pubescent. Leaves 2-pinnate, with glands on the petiole and at the base of

each pinna and leaflet. Pinnae 1–2 (rarely 3) pairs, the lowest pair smallest. Leaflets 1–2 (rarely 3) pairs, 3–6 by $1\frac{1}{2}$ in., the terminal pair the largest, elliptic-lanceolate or obovate-oblong. Heads few-

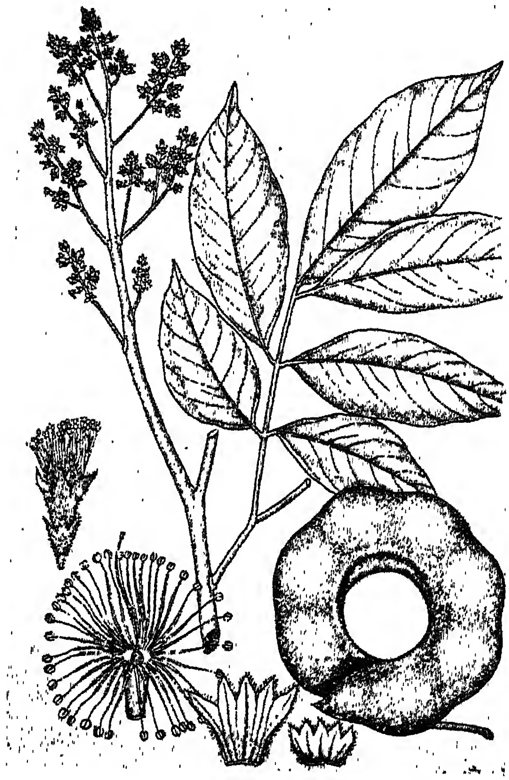

FIG. 78. *Pithecellobium bigeminum* Mart.

flowered, arranged in small peduncled clusters on branches of panicles. Calyx $\frac{1}{12}$–$\frac{1}{10}$ in. long, campanulate. Corolla pale-yellow or cream-coloured, silky outside, 2–3 times the calyx-length. Pod flat, once or twice spiral, bright-red within, not indented between the seeds. Seeds 5–8, black.

Distribution

Found in the Eastern Himalayas, Khasia and Jaintia Hills, Konkan, North and South Kanara, the Western Ghats of Madras Presidency from Mysore to Anamalais and Travancore, ascending to an altitude of 3,000 ft.

Uses and properties

A decoction of the leaves is used as an external application in Upper India in leprosy and as a stimulant for the growth of hair.

The seeds are in great demand in certain parts of Burma where the people use them as a condiment after repeatedly boiling them in water and discarding the water every time. Creais (*96*) refers to the alarming symptoms that are sometimes produced. Usually there is vomiting with abdominal pain. If uncooked seeds were eaten, violent and persistent vomiting may prevent appearance of further symptoms. The urine is suppressed, and there is severe pain in the loins and the bladder. Strangury occurs with the passage of a few drops of urine, which is often blood tinged. Later, when the flow of urine occurs, there may be free haematuria. Headache and giddiness are present; the vision is blurred and the conjunctivae are suffused; muscular cramps occur, particularly in the extremities. The symptoms generally set in quickly and are very severe. According to Creais, the poisoning from the seeds causes death of the unborn child.

The plant is poisonous to fish (*6*). Some other species have also been recorded as piscicides, *e.g.*, *P. ellipticum* (Blume) Hassk. of Java.

Constituents

The bark contains 0·8 per cent of an alkaloid which acts as a fatal poison to fish in a dilution of 1 : 400,000 (*97*); it also contains a saponin (*98*).

The leaves contain two acids, but no alkaloids, glucosides or tannins (*99*).

22. PONGAMIA Vent.

(From the Tamil name, *pongam.*)

Botanical characters and distribution

A single Indo-Malayan species with the floral characters of *Derris*, from which it differs in having an oblong woody pod which is not at all winged.

Pongamia pinnata (Linn.) Merr.

P. glabra Vent., Fl. Brit. Ind., II, 240.

(Indian Beech, Karanj-oil Tree)

Vernacular names: ARABIC—Akte-makat; BENGAL—Dahar-karanja, Dalkaramcha, Dar-karanja, Karanja, Karmuj, Khawari; BURMA—Simizu, Thawen, Thengweng, Thinwin, Timizu; CENTRAL PROVINCES—Kurunji; GOND—Garanji; GUJERATI—Kanaji, Karanj, Karanjnu; HINDI—Kanja, Karanj, Karanjaka, Kiramal, Papar; KANARESE—Batti, Honge, Hunge, Huligili, Kanaga, Karanja, Pong; KUMAON—Paper, Sukhchain; MALAYALAM—Minnari, Punnu, Unnu; MARATHI—Ghanera-karanj, Karanj, Karanja; OUDH—Kanji, Papar; PERSIAN—Khaiul-malisa; PUNJAB—Karanj, Paphri. Sukhchein; RAJPUTANA—Charr; SANSKRIT—Karanja, Naktamala, Tamalavriksha; SANTAL—Kuruinj; TAMIL—Agiru-nanandam, Ilanji, Kanjanam, Kolliyam, Naguttam, Nanandam, Nattam, Nattamalam, Nir-pungu, Ponga, Pongam, Pungam-maram, Pungu, Tattai-pungu, Udagu; TELUGU—Ganguga, Kaggera, Kagu, Kanga, Kanuga, Kranuga, Krovi, Ranagu, Viaghranakamu; TULU—Korangi, Kurundi, Pungu; URDU—Karanjvah; URIYA—Konja, Koranju, Koronja, Karansa.

Botanical characters

A moderate-sized glabrous almost evergreen tree. Leaves 8–10 in. long, imparipinnate, pale-green; leaflets opposite, usually 5–7, 2–4 in. long, oblong or ovate, obtuse or shortly acuminate. Flowers in simple

FIG. 79. *Pongamia pinnata* (Linn.) Merr.

peduncled axillary racemes nearly as long as the leaves. Corolla ½ in., white tinged with violet or pink; standard silky on the back. Stamens monadelphous. Ovary subsessile, finely pubescent, 2-ovuled. Pod 1½–2 by ¾–1 in., with a short decurved point, flattened, woody, glabrous, brownish-green, 1- rarely 2-seeded, indehiscent.

Distribution

This tree is met with all over India on the banks of rivers and streams, especially near the seacoast and some forest localities; often planted as a roadside tree. It sometimes flowers as a shrub on the seacoast.

Uses and properties

The leaves of this plant are given to cattle as fodder, and are said to act as a lactagogue in cows. The pods are largely collected for the sake of seeds, which yield a valuable, thick, red-brown oil which is used for illumination and medicinal purposes. The powdered seeds are also very commonly used for their expectorant properties in bronchitis and whooping cough.

The information regarding the leaves, the oil, and the juice from the stem and the root seems to point to their having more or less antiseptic properties, but further investigation is desirable. The oil is held in high esteem as an application in the treatment of scabies, herpes, and other cutaneous diseases ; it is also considered useful in rheumatism. A poultice of leaves is considered to be very useful for ulcers infested with maggots, etc. The juice of the root is used for cleansing foul ulcers.

The seeds and roots are said to be poisonous to fishes. " A 2 per cent *P. glabra* oil-resin spray has been stated to be highly toxic against the nymph and adult stages of the green bug (*Coccus viridis*) on coffee " (*100*).

Constituents

The seeds contain 27 to 36·4 per cent of a bitter fatty oil and traces of an essential oil (*6*).

23. SOPHORA Linn.

(Altered from *sophero*, the Arabic name of some tree with pea-shaped flowers.)

Botanical characters

Trees or shrubs. Leaves odd-pinnate. Flowers showy, yellow or purple, racemed or panicled ; bracts and bracteoles minute or 0, caducous. Calyx oblique, broadly campanulate ; teeth very short. Corolla much exserted ; standard broad ; petals long-clawed. Stamens 10, free, or obscurely connate at the very base. Ovary stalked, many-ovuled ; style incurved ; stigma terminal, minute. Pod moniliform, usually indehiscent, the joints turgid, terete or 4-winged.

Distribution

Tropics and warm temperate regions.

Toxic aspects

This genus consists of 25 species of which 8 are found in India. Of the Indian species, *S. tomentosa* Linn. contains an alkaloid named sophorine, which is identical with cytisine. Cytisine has been fully discussed under *Cytisus*, and its insecticidal properties have also been referred to. It is of interest to note here that the seeds of some Indian species of *Sophora* are used as insecticides, and the investigation of these and other plants belonging to this genus may yield results of practical importance. The roots and herbage of members of this genus are considered antiseptic, subastringent, cathartic, and emetic.

KEY TO THE SPECIES

a. Pod with 4 wings. Leaflets 21–35 .. 1. *S. mollis*.

b. Pod without wings or ridges. Leaflets 15–17 .. 2. *S. tomentosa*

1. Sophora mollis R. Grah.

Fl. Brit. Ind., II, 251.

(Himalayan Laburnum)

Vernacular names: AFGHANISTAN—Arghavan; ARABIC—Arghavan; GARHWAL—Sakina; PERSIAN—Arghavan; PUNJAB—Ban-kcinti, Brisari, Buna, Kathi, Kohen, Kun, Malan, Tarni, Tilun; URDU—Arghavan.

Botanical characters

A low spineless shrub with finely grey-downy branches. Leaves about 6 in. long; leaflets 21–35, opposite or alternate, $\frac{1}{2}$–$\frac{3}{4}$ in. long, ovate or elliptic, obtuse, emarginate, greyish-green, finely downy. Flowers appearing before the leaves, arranged in short dense axillary racemes shorter than the leaves. Calyx finely grey-downy. Corolla about $\frac{3}{4}$ in. long, yellow. Pod 3–4 in. long, moniliform, glabrous, 4–6-seeded, the joints with 4 distinct crustaceous wings.

FIG. 80. *Sophora mollis* R. Grah.

Distribution

Found in the Himalayas and Sub-Himalayan tracts of North-Western India from Gilgit, Chitral, Hazara, and the Salt Range to Kumaon and

Nepal, ascending to an altitude of 7,000 ft. It is common locally near Malakand, in Kagan and Kilba, Bushahr, and Sahansradhara near Dehra Dun. The variety *hydaspidis* Baker, with the leaves and calyx more densely and persistently silky and larger flowers, has been reported from the Salt Range in the Punjab.

Toxicity According to Watt (*1*), goats browse upon this plant but it is said to be fatal to other animals; he also classifies the variety *hydaspidis* as poisonous. Kirtikar and Basu (*19*) describe the seeds as useful for destroying vermin.

2. Sophora tomentosa Linn.

Fl. Brit. Ind., **II**, 249.

Vernacular name: BURMA—Thinbawmagyi.

Botanical characters A small tree or robust shrub, the branches and whole plant covered with short, soft, grey-velvety pubescence. Leaves up to 8 in. long; leaflets 15–17, 1–1½ in. long, broadly oval, obtuse, thinly downy above, the lower surface with more dense pubescence. Flowers ⅘–1 in., yellow, in racemes about 6 in. long; pedicel as long as the densely velvety calyx, jointed near the top. Pod long-stalked, 2–6 in., moniliform, the joints separated by narrow necks as long as themselves, sharply pointed, covered with velvety down, 1–8-seeded.

Distribution Found in the Andaman and Nicobar Islands; very occasionally cultivated in Indian gardens.

Uses and properties Various parts of the plant are stated to be used in medicine; the leaves are powerfully emeto-cathartic and toxic in large doses (*19*). According to Pammel (*2*), the plant possesses soporific properties.

The use of this plant for insecticidal purposes has not been noted in literature, but it is very likely that proper investigation may yield positive results.

Constituents The seeds contain about 2·06 per cent of the poisonous alkaloid cytisine—sophorine (*101*), which has been fully discussed under *Cytisus*.

24. TEPHROSIA Pers.

(From the Greek *tephros*—ash-coloured: referring to the pubescence of most species.)

Botanical characters Herbs or undershrubs, rarely shrubs. Leaves imparipinnate rarely simple; leaflets opposite, subcoriaceous, obliquely parallel-veined, often silky beneath. Flowers white or red, in terminal, leaf-opposed or less

often axillary racemes, or solitary or in pairs in the leaf-axils. Calyx campanulate; teeth subequal. Petals clawed; standard suborbicular; wings slightly adherent to the incurved keel petals. Stamens diadelphous. Ovary many-ovuled; style incurved, glabrous or bearded; stigma terminal, often penicillate. Pod linear, flattened, many-seeded, 2-valved, continuous or obscurely septate between the seeds.

Distribution

Tropical and subtropical regions.

Insecticidal and piscicidal aspects

There are about 140 species of this genus, of which not a few are known to be piscicides and parasiticides. About a dozen species are found in India, and some of these are commonly met with; two of these are reported to be used as fish poisons. Considering that some of the plants of this genus possess well-marked insecticidal properties, it is important to investigate some of the Indian representatives, especially those which are known to be poisonous to fishes and which are described in detail hereafter. It is proposed to deal here with *T. vogelii* Hook. *f.* (fish bean of Northern Rhodesia) at some length because of its having been already adopted in South Africa as a useful insecticide. Furthermore, we have recently been informed that this plant is largely cultivated in the tea gardens of Assam for use as a nitrogenous manure.

Both the root and the leaf of *T. vogelii* are used as a fish poison, and the leaf is also said to be an efficient insecticide against fleas, lice, and ticks; in the dry state it is used as a flea powder. It has also been suggested that the plant might be used as a commercial dip for cattle.

Hanriot (*102*) isolated from the leaves a crystalline neutral substance with a melting point of 187°C. which he called tephrosin, a volatile oil called tephrosal, and a yellow substance. The Imperial Institute, London (*103*) confirmed the presence of tephrosin in the plant, and found that the leaves yield 0·15 per cent of tephrosin and the seeds 0·3 per cent of the toxic substance. Clark (*104*), who examined the leaves of this plant, thinks that Hanriot's tephrosin was a mixture of deguelin with a melting point of 171°C. and a colourless crystalline substance with a melting point of 198°C.; he proposes that the name tephrosin be retained for the compound melting at 198°C. Merz (*105, 106*) obtained from the seeds tephrosin, deguelin, dehydrodeguelin, *allo*tephrosin, and *iso*deguelin.

Hanriot's tephrosin was found to be particularly toxic to fishes, but much less so when given orally to other animals. The minimum fatal concentration for fish was found to be 1/50,000,000; salt-water fishes are less susceptible to the poison than fresh-water ones.

Rabbits took the leaves of this plant without untoward effects ; a gram of tephrosin given with food to a dog was without effect. Hanriot found the minimum lethal dose of his tephrosin given hypodermically to be 0·01 gm per kgm in rabbits and dogs, death being due to paralysis of respiration.

Watery and alcoholic extracts of the leaves or seeds are highly toxic to *Aphis rumicis* Linn. (the bean aphis), the toxicity being of the same order as that of nicotine (*107*).

Chopra and collaborators (*108*) have recently investigated the larvicidal and insecticidal action of the leaves of *T. vogelii* grown in Assam. They conclude that the leaves do not possess insecticidal properties to any marked degree. The acetone extract of the leaves (*108*) and of seeds (*109*) has, however, proved an effective larvicide in the case of plants grown in India, but owing to the prohibitive cost of acetone its wide application in the field cannot be considered.

KEY TO THE SPECIES

a. Shrub. Flowers white or tinged with red. Style silky .. 1. *T. candida*.

b. Suberect herbaceous perennial. Flowers purple. Style glabrescent .. .. 2. *T. purpurea*.

1. Tephrosia candida (Roxb.) DC.

Fl. Brit. Ind., **II**, **111**.

Vernacular name : HINDI—Lashtia.

Botanical characters

A weak shrub 5-8 ft. high, with grooved branches clothed with brown or grey persistent velvety pubescence. Leaves 6–9 in. long ; leaflets 13–29, 1–3 in. long, narrowly elliptic, cuspidate at apex, pale and silky beneath. Racemes 3–9 in. long, axillary and terminal. Calyx densely silky ; teeth deltoid, shorter than the tube. Corolla $\frac{3}{4}$–1 in., white or tinged with red. Style silky. Pod 3–4 in., brown-sericeous, slightly curved, 10–15-seeded.

Distribution

Found in the tropical Himalayas from Garhwal to Khasia and Assam up to an altitude of 5,000 ft. in Sikkim ; also in Chittagong and in the Sameshwar Hills. Occasionally grown as an ornamental plant.

Uses and properties

This plant has been recorded by Gamble (*110*) as a fish poison in Eastern Bengal and Burma ; the bark and leaves are chiefly used for this purpose. An extract of the seeds has been tested for its insecticidal properties on a small scale in the field, and found to be quite

efficacious. Ethyl alcohol alone has been stated to effect complate extraction of the active material.

FIG. 81. *Tephrosia candida* (Roxb.) DC.

2. Tephrosia purpurea (Linn.) Pers.

Fl. Brit. Ind., II, 112, in part.

(Bastard Indigo, Wild Indigo)

Vernacular names : BENGAL—Ban-nil, Sarphonka ; DECCAN—Hunnali, Janglikulthi ; GUJERAT—Ghodakan, Jhila, Sarpankho, Sharpankho ; HINDI—Sarphanki, Sarphoka, Sarphonka, Sarphuka ; KANARESE—Empali, Kogge, Koggili, Phanike ; MADRAS—Mollu-kay ; MALAYALAM—Kolinnil, Kozhinnila ; MARATHI—Sharapunkha, Sirapakha, Udhadi, Unhal ; MUNDARI—Bir-ka-konda, Birka-konta, Lil-ka-konda ; PANCH MAHALS—Jhil ; PORBANDAR—Ghodakan, Sarpankho ; PUNJAB—BANSA-bansu, Jhojhru, Sarpankh, Sarphonka ; SANSKRIT—Sarapunkha ; SIND—Surpunka ; TAMIL—Kat-kolingi, Kolluk-kay-velai ; TELUGU—Bonta-vempali, Mulu-vempali, Nela-vempali, Nempali, Tella-vempali, Tella-yampali, Yampali ; URDU—Sarabhuka ; URIYA—Kolothiyapokha, Mohisiakolothiya, Pokha, Soropokha.

Botanical characters

A copiously branched suberect herbaceous perennial 1–2 ft. high; branches glabrous or nearly so. Leaves 3–6 in. long; leaflets 13–21, $\frac{3}{4}$–1 in. long, oblanceolate, obtuse or retuse, mucronate, glabrous above, obscurely silky beneath. Flowers $\frac{1}{4}$ in. long, purple, in leaf-opposed lax racemes 3–6 in. long, the lower flowers fascicled. The Calyx-teeth linear-subulate, as long as the tube. Style flattened, glabrescent; stigma penicillate. Pod $1\frac{1}{2}$–2 in. long, finally glabrescent, slightly curved, 6–10-seeded.

Distribution

Found all over India, ascending in the Himalayas up to an altitude of 6,000 ft.

Uses and properties

The odour of the decaying plant is very offensive. The bitter root has been stated to be used in cases of dyspepsia, tympanitis, chronic diarrhoea, and as an anthelmintic. The plant has also been used as deobstruent and diuretic, and is considered useful in bronchitis, bilious febrile attacks, as a purifier of the blood, and in the treatment of boils, pimples, etc.

The root is used to poison fish in French Guiana, but no such use has been reported in India.

Constituents

The roots contain tephrosin, deguelin, *iso*tephrosin, rotenone, etc. (*111*). The leaves contain about 2 per cent of a glucoside, osyritin (*112*).

25. TRIFOLIUM (Tourn.) Linn.

(The Latin name for clover; referring to the three leaflets.)

Botanical characters

Herbs. Leaves digitately trifoliolate, the stipules adnate to the petiole. Flowers small, copious, in dense axillary heads, spikes or umbels, red or white, sometimes yellow. Calyx-tube campanulate; teeth mostly 5, subequal. Corolla adnate to the staminal tube and fading without falling; standard and wings narrow; keel straight, obtuse. Stamens diadelphous; filaments more or less dilated. Pod minute, included, membranous, indehiscent, 1- or few-seeded.

Distribution

Most in Europe and Asia, and also in North America and tropical Africa.

Photosensitization

Some authors refer to "photosensitization" produced by *Trifolium pratense* Linn. (red clover or cow grass) and *T. hybridum* Linn. (alsike clover) when animals take large amounts of, or are fed exlusively on, these plants. Both of them are valuable for forage. *T. pratense* is found in India, extending from Kashmir to Garhwal at altitudes of 4,000 to 8,000 ft., and is one of the common forage clovers in these regions; it is also regarded as a good cropper where the commoner clover fails.

Symptoms

The symptoms of poisoning are very similar to those described under *Fagopyrum esculentum* Moench. Unpigmented and unprotected portions of the skin are affected. In severe cases, a phlegmonous stomatitis may appear. Horses are stated to be more susceptible than cattle (5).

Trifolium repens Linn.

Fl. Brit. Ind., II, 86.

(Dutch Clover, White Clover)

Vernacular names : PUNJAB—Shaftal, Shotul : PUSHTU—Ghurg.

Botanical characters

Perennial ; stems creeping and rooting at the joints. Leaflets obovate, toothed, veins prominent, tip notched ; terminal leaflet sessile.

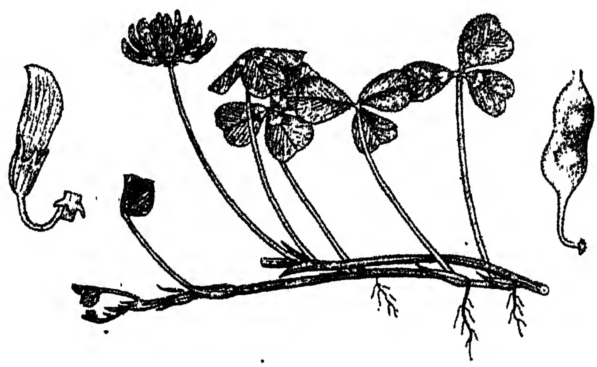

FIG. 82. *Trifolium repens* Linn.

Stipules narrow, much shorter than the petiole. Heads globose, $\frac{3}{4}$–$1\frac{1}{4}$ in. diam. ; peduncles long, naked. Flowers white or tinged with pink, shortly stalked, finally deflexed. Calyx not accrescent. Pod 2–4-seeded.

Distribution

Common in many parts of the temperate and alpine Himalayas, ascending to 20,000 ft. ; also found wild at high levels in the Nilgiris, where perhaps it was introduced.

Uses and properties

This is one of the most highly prized fodder plants of Europe, but in the Himalayas, unfortunately, it has the evil reputation of readily

causing excessive salivation. Watt (*1*) reports that he has seen several horses suffering very badly from its effects, one with fatal results. He further adds that in each case the attendants were confident that this was due to the animals having eaten the wild white clover. Our inquiries more or less confirm this account.

Constituents — The fresh plant contains a cyanogenetic glucoside yielding 0·0016 to 0·0124 per cent of hydrocyanic acid; the amount of the acid is greater in the stems than in the leaves, but varies with the season (*113*).

26. VICIA Tourn. *ex* Linn.

(The classical name of some kind of vetch, probably *Vicia sativa* Linn.)

Botanical characters — Climbing or diffuse herbs. Leaves paripinnate, ending in twisted tendrils. Flowers subsessile or in peduncled axillary racemes. Calyx-tube campanulate, often oblique; teeth unequal. Corolla more or less exserted; standard broad; keel shorter than the wings. Stamens diadelphous, the mouth of sheath very oblique. Ovary 2–many-ovuled; style filiform or slightly flattened, usually pubescent or bearded. Pod compressed, continuous within.—Scarcely differing from *Lathyrus* except in the staminal sheath and the style.

Distribution — Mostly in the north temperate zone.

Vicia sativa Linn.

Fl. Brit. Ind., II, 178.

(Spring Vetch, Tare, Vetch)

Vernacular names: BENGALI—Ankari; HINDI—Ankra, Akra, Akta; URIYA—Rothi.

Botanical characters — An annual with slender suberect stems. Leaflets 8–12, those of the upper leaves $\frac{3}{4}$–1 in. long, ligulate, of lower shorter and broader. Flowers solitary or paired, $\frac{3}{4}$ in., reddish-blue. Style bearded on the lower side near the tip. Pod $1\frac{1}{2}$–2 in., glabrescent, 8–10-seeded.

Distribution — Generally found as a weed of cultivation from Bengal onwards to the northern parts of India, ascending to an altitude of 7,500 ft. in the Western Himalayas; also run wild in the Nilgiri Hills, about Ootacamund.

Variety — Var. *angustifolia* Baker—Smaller and more diffuse. Leaflets shorter, those of the lower leaves deeply emarginate. Flowers and pods smaller.

Distribution — Abundant as a weed in cultivated ground throughout Northern India.

Uses and properties — This plant is a favourite fodder for cattle. Of late years the seeds of the variety *angustifolia* have been implicated in the causation of lathyrism, a disease fully described under *Lathyrus*. Although some

of the symptoms observed by Howard and his collaborators (67) in monkeys fed on diets containing seeds of this plant are suggestive,

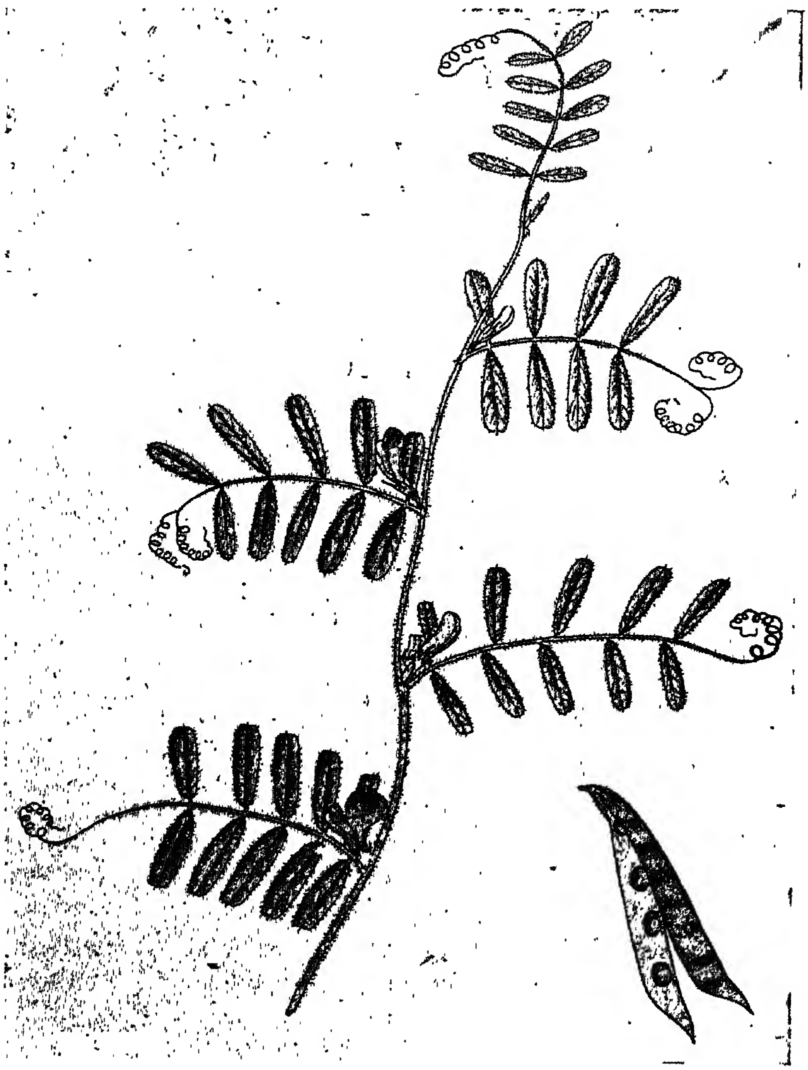

FIG. 83. *Vicia sativa* Linn.

there is still insufficient evidence to connect lathyrism in man with the ingestion of these seeds. Besides other things, a more universal contamination by vicia of lathyrus seeds of various origin, than what the present authors believe to be probable, will have to be proved before

attaching any importance to vicia in the production of naturally occurring lathyrism, at least in man in India.

The seeds of the variety *angustifolia* contain a cyanogenetic glucoside vicianin and also the gluco-alkaloid vicine. Vicine, which is present in the largest amount in the immature seeds, yields on hydrolysis a base divicine and d-glucose. Divicine produces on inoculation in guinea pigs a characteristic and fatal disease. The seeds when fed to ducks cause death; in monkeys they produce a very characteristic train of symptoms affecting the nervous and muscular systems, resembling lathyrism (*67*). The amount of the cyanogenetic glucoside vicianin found in a sample of seeds examined was about 0·9 per cent, and it is stated that the seeds which are capable of furnishing 0·75 gm of hydrocyanic acid per kgm are not suitable as food for domestic animals (*114*).

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Family XXX.—ROSACEAE

(Rose Family)

Botanical characters

Herbs, shrubs or trees. Leaves alternate (rarely opposite), simple or variously compound, stipulate. Flowers usually regular and hermaphrodite. Calyx-tube free from or adnate to the ovary, usually 5-lobed, often bracteolate. Petals as many as the sepals or rarely wanting, inserted under the margin of the disc, deciduous, imbricate. Disc lining the calyx-tube or forming a ring at its base. Stamens usually numerous, perigynous. Ovary of 1 or more free or connate carpels, with free or connate basal lateral or terminal styles; stigmas simple, penicillate or capitate; ovules 1 or more in each carpel. Fruit various, of achenes, berries, drupes or pomes, rarely capsular, often formed in part from the calyx-tube. Seeds exalbuminous.

Distribution

A very large family spread over nearly the whole globe, but most abundant in north temperate regions.

Economic aspects

Many plants of this family are cultivated for ornamental purposes and some are of economic importance. It furnishes a large number of valuable fruits, such as the apricot (*Prunus armeniaca* Linn.), peach [*P. persica* (Linn.) Stokes], almond (*P. amygdalus* Batsch), sweet cherry or gean (*P. avium* Linn.), plums and prunes (*P. domestica* Linn.), 'alucha' (*P. communis* Huds., var. *insititia* Hook. *f.*), cherries (*P. cerasus* Linn. and others), loquat [*Eriobotrya japonica* (Thunb.) Lindl.], strawberry (*Fragaria vesca* Linn.), apple (*Pyrus malus* Linn.), pear (*P. communis* Linn. and *P. sinensis* Lindl.), quince (*Cydonia oblonga* Mill., syn. *Pyrus cydonia* Linn. and *Cydonia vulgaris* Pers.), etc. Oil of roses is obtained from certain species of *Rosa* which are also cultivated in gardens. The mucilaginous seeds of *Cydonia oblonga* have been used in indigenous medicine for a long time as a demulcent in the treatment of gastro-intestinal and other conditions. Some plants of the family are used for medicinal purposes, and the root, bark, leaves, and flowers of these are said to possess astringent, tonic, anthelmintic, and antiperiodic properties.

Toxic aspects

The poisonous properties of many of the plants of this family are due to the presence of cyanogenetic glucosides, such as amygdalin, prunasin, and prulaurasin, which have been found to occur in the leaves, bark, and seeds. Of these, amygdalin occurring in bitter almonds (*Prunus amygdalus* Batsch, var. *amara* of authors) is well known. On hydrolysis amygdalin produces hydrocyanic acid which is responsible for its

poisonous action. Cyanogenetic glucosides are also present in many other plants belonging to widely different families, *e.g.*, Gramineae, Leguminosae, etc.

The bark of *Quillaja saponaria* Molina of Chile (soapbark tree) contains a sapotoxin, and is used for dressing wool and silk. The tree is cultivated for ornamental purposes in the North-West Frontier Province. The pistillate flowers of *Brayera anthelmintica* Kunth, which is a large ornamental tree indigenous to North-East Africa, have been used from ancient times as a taeniafuge under the name of kousso or cusso. They contain kosotoxin, a powerful protoplasmic poison, which in large doses produces gastro-intestinal irritation. The male flowers are powerfully emetic and, therefore, useless as vermicide.

Some cherries are known to cause stock poisoning, and the seeds when taken internally may produce fatal results.

Constituents

The following are some of the important chemical constituents found in the members of this family: (*a*) *cyanogenetic glucosides*, such as amygdalin, prulaurasin, prunasin, etc., (*b*) other *glucosides*, such as phloridzin, gaultherin, gein, sakuranin, etc., (*c*) *saponins*, such as those found in *Spiraea*, *Quillaja*, etc., (*d*) *toxic substances*, such as kosotoxin, etc., and (*e*) *essential oils* having such constituents as geraniol, citronellol, benzaldehydecyanhydrin, benzaldehyde, hydrocyanic acid, methyl salicylate, salicylic aldehyde, etc.

KEY TO THE GENERA

A. Ovary superior; the ripe carpels not enclosed within the calyx-tube.
- I. Carpel 1. Style terminal.
  - *a*. Petals large .. .. .. 1. *Prunus.*
  - *b*. Petals minute or 0 .. .. .. 2. *Pygeum.*
- II. Carpels 5 or more. Style subterminal.
  - *a*. Prickly shrubs. Fruit succulent .. 4. *Rubus.*
  - *b*. Unarmed shrubs. Fruit dry, indehiscent .. 5. *Spiraea.*

B. Ovary inferior; carpels connate and adnate to the calyx-tube. Fruit a pome .. .. .. 3. *Pyrus.*

1. PRUNUS (Tourn.) Linn.

(The classical name of the plum tree.)

Botanical characters

Mostly unarmed shrubs or trees. Leaves simple, quite entire or sessate or crenate or glandular-serrulate; petiole often 2-glandular. Flowers white or pink, solitary, fascicled, corymbose or racemed. Calyx deciduous in fruit; lobes 5. Petals 5, large. Stamens 15–60.

Carpel solitary; style terminal; ovules 2, collateral. Fruit a drupe with an indehiscent or 2-valved, 1-seeded, smooth or rugged stone..

Distribution

North temperate regions, rarely in tropical climes.

Economic and toxic aspects

In therapeutics, the fruits are used as a mild laxative and tonic; the barks are often bitter and are stated to be antiperiodic.

From the toxicological point of view hydrocyanic acid is the most important constituent, and occurs in combination in the form of cyanogenetic- or hydrocyanic-acid-producing glucosides. These glucosides by themselves are almost entirely harmless, except when they are decomposed by means of enzymes either in the plant or in the body of the animal. In most plants the glucoside coexists with the corresponding enzyme by which it is split up in presence of water into hydrocyanic acid and other components.

Amygdalin, the glucoside of bitter almonds, is a typical example. It is also found in small amounts in peach kernels, plums, cherries, etc., and the preparation of hydrocyanic acid from such sources appears to have been known to the early Egyptian priests.

The cherry laurel (*Prunus laurocerasus* Linn.), one of the ornamental shrubs of southern Europe, contains the cyanogenetic glucoside prulaurasin in the leaves, and gives rise to poisoning in livestock. Poisonous properties of all species of cherry leaves are due to the formation of hydrocyanic acid. The available evidence shows that the leaves while still on the tree are practically harmless. The wilted ones have the characteristic odour of hydrocyanic acid, and are considered dangerous. The dried leaves must, however, be regarded with suspicion. Recent observations show that the young leaves of *P. padus* Linn. contain prunasin or amygdonitrile glucoside. While the seeds of most varieties of cherries are subject to suspicion, the flesh of almost all is harmless.

As regards the mechanism of poisoning, it is necessary to emphasize the following points (*1*): (*a*) In the dried material, the enzyme and the glucoside are not in contact and, therefore, no hydrolysis with the formation of hydrocyanic acid occurs. (*b*) After mastication the puiped mass at the body temperature is in a very favourable condition for hydrolysis, and the liberation of hydrocyanic acid is, therefore, rapid in the rumen or stomach. (*c*) The enzyme is destroyed above 60°C. in moist heat, but destruction by dry heat requires prolonged heating at about 100°C. (*d*) The cyanogenetic glucosides by themselves neither appear to be poisonous nor are they acted upon by the various digestive ferments.

KEY TO THE SPECIES

A. Leaves conduplicate in bud. Flowers subsessile. Drupe usually pubescent; stone bony, rugged.
- I. Pericarp 2-valved .. .. .. 1. *P. amygdalus.*
- II. Pericarp indehiscent .. .. .. 7. *P. persica.*

B. Leaves convolute in bud. Flowers sessile or peduncled. Drupe large, indehiscent, downy; stone bony, smooth 2. *P. armeniaca.*

C. Leaves conduplicate in bud. Flowers solitary, fascicled, umbelled or corymbose. Calyx-tube short or long. Drupe glabrous, not glaucous.
- I. Flowers solitary, fascicled or umbelled.
  - *a*. Flowers appearing with the leaves.
    - *aa*. Roots without suckers .. .. 3. *P. avium.*
    - *bb*. Roots with many suckers .. 4. *P. cerasus.*
  - *b*. Flowers appearing before the leaves .. 8. *P. puddum.*
- II. Flowers in corymbose racemes, fragrant .. 5. *P. mahaleb.*

D. Leaves conduplicate in bud. Flowers in axillary or terminal, many-flowered racemes. Calyx-tube short, obconic. Drupe glaucous or not.
- I. Drupe globose, stone rugose. Flowers $\frac{1}{4}$–$\frac{1}{3}$ in. diam. Stamens 30–40 .. .. 6. *P. padus.*
- II. Drupe ovoid, stone smooth. Flowers $\frac{1}{6}$ in. diam. Stamens 15–20 .. .. .. 9. *P. undulata.*

1. Prunus amygdalus Batsch

P. amygdalus Baill., Fl. Brit. Ind., II, 313.

(Almond Tree)

Vernacular names: ARABIC—Louz, Lujaalhulu; BENGAL—Badam, Bilatibadam; BURMA—Badan; DECCAN—Badam; GUJERATI—Badam; HINDI—Badam; KANARESE—Badami; KONKANI—Amend, Amendi; MALAYALAM—Badam, Vadam-kotta; MARATHI—Badam; PAB HILLS—Archin; PERSIAN—Badam; PUNJAB—Badam; SANSKRIT—Badama, Badamitte, Netropamaphala, Suphala, Vatada, Vatavairi; TAMIL—Parsi-vadumai, Vadam-kottai, Vadumai; TELUGU—Badamamu, Badamu, Parsi-badami; URDU—Badam, Badam-shirin, Badam-talkh; URIYA—Badamo.

Botanical characters

Small to medium-sized tree with oblong-lanceolate, serrulate leaves; petiole glandular, as long as or longer than the breadth of the leaf; stipules fimbriate. Flowers copious, peduncled, white tinged with red, appearing before the leaves. Drupe velvety; pericarp dry, separating into 2 valves when ripe; stone compressed, with shallow wrinkles and minute holes.

Distribution

Cultivated in the cooler parts of the Punjab and Kashmir.

Uses and properties

Two varieties, *viz.*, *amara* and *dulcis*, the bitter and sweet almonds, are recognized, but these cannot be distinguished by any permanent botanical characters. Sweet almonds are largely used as a dessert and in confectionery, and are considered as a demulcent and stimulant nervine tonic in indigenous medicine. Applied to the head, almond paste, probably of the bitter variety, is stated to kill lice.

Almonds yield two distinct oils, a fixed or fatty oil and an essential oil. The sweet almonds do not yield any essential oil, but the yield of *Constituents*

FIG. 84. *Prunus amygdalus* Batsch

fixed oil is about the same as in the case of bitter almonds, varying from 35·5 to 62·5 per cent.

The " essential oil of almonds " or the " oil of bitter almonds " is not present as such in the almonds, but is formed by hydrolysis of the glucoside amygdalin by the enzyme emulsin, which is found in the seeds. It is obtained by submitting the bitter-almond cake, left after expression of the fixed oil, to distillation in steam, the yield being 0·5 to 0·8 per cent. The chief constituents of the essential oil are benzaldehyde (known as oil of bitter almonds which can also be prepared synthetically), hydrocyanic acid, and benzaldehydecyanhydrin (or mandelonitrile).

Emulsin, the enzyme which hydrolyzes the cyanogenetic glucoside amygdalin, is present in sweet almonds also. Dunstan and Henry have shown that traces of hydrocyanic acid also occur in the seeds and more than traces in the seedlings of sweet almonds; it is probable, therefore, that a small quantity of amygdalin does occur in the sweet variety also (*2*).

In bitter almonds, amygdalin is present to an extent of 2 to 8 per cent, and there is scarcely any free hydrocyanic acid (*3*). On an average, they contain about 3 per cent of amygdalin, and each almond roughly about 1 mgm of hydrocyanic acid; about 60 almonds will thus provide a lethal dose for an adult man. On macerating the seeds in water, the enzyme is brought into contact with dissolved glucoside, hydrolyzing it into glucose, benzaldehyde, and hydrocyanic acid. The crude oil of bitter almonds, which may contain up to 14 per cent of hydrocyanic acid, is naturally very poisonous. The pure oil (benzaldehyde), on the other hand, has nothing in common with hydrocyanic acid in its action, and very large doses only are stated to produce spasms which resemble epileptic fits. The quantities in which it often occurs in perfumes, liqueurs, and confectionery may be considered harmless.

2. Prunus armeniaca Linn.

Fl. Brit. Ind., II, 313.

(Apricot)

Vernacular names: ARABIC—Bin-kuk, Kishanish, Toffa-urmena; AFGHANISTAN—Zardalu; BHUTIA—Chuli, Pating; HAZARA—Hari; HINDI—Chilu, Chulu, Chuari, Jaldaru, Khubani, Zardalu; KASHMIR—Cherkush, Gurdalu, Iser; KONKANI—Jardal; KUMAON—Chola, Chuaru, Jaldaru, Kushmaru, Zardaru; LADAKH—Chuli; NASIRABAD—Zardalu; NORTH-WESTERN HIMALAYAS—Chilu, Chuli, Shari; PERSIAN—Mishmish, Zardalu; PUNJAB—Alu-kashmiri, Arti, Cherkush, Cheroli, Chir, Chuli, Gurdalu, Hari, Jaldaru, Jaldaru-chuli, Khhamani, Khubani, Kishta, Kush, Mandata, Sari, Serkuji, Shari, Shiran, Zardalu; PUSHTU—Mandata, Nakhter; QUETTA—Zardalu; TIBET—Galdam; URDU—Khubani.

Botanical characters

A medium-sized deciduous tree. Leaves appearing after or with the flowers, 2 to 3 in. long, broadly ovate, acuminate, crenate; petiole glandular; stipules lanceolate. Flowers shortly pedicelled, pinkish at first, then white. Calyx-tube campanulate. Drupe yellow tinged with red; stone smooth with a thickened grooved margin.

Distribution

Commonly cultivated in North-Western India, especially in the hills at altitudes of 6,000 to 9,000 ft.

Uses and properties

The apricot is a favourite fruit and is eaten both fresh and dried. The seeds are eaten in the same way as almonds and in fact form a valuable substitute; the oil expressed from these is largely used as an

illuminant, for cooking, etc., especially in the north-western parts of India. As in the case of almonds, there is also a bitter "variety" of the seeds which is undoubtedly poisonous.

Constituents Amygdalin has been found in the seeds (*4*), probably of the bitter "variety."

3. Prunus avium Linn.

Fl. Brit. Ind., II, 313.

(Cherry, Sweet Cherry, Gean)

Vernacular names: KASHMIR and KUMAON—Gilas, Krusbal.

Botanical characters A medium-sized tree producing no root-suckers. Leaves flaccid, drooping, oblong-obovate, acutely serrate, pubescent beneath; petiole long, 2-glandular. Flowers fascicled, long-pedicelled; flowering buds leafless. Calyx-tube urceolate, constricted at the top; lobes entire. Petals flaccid, spreading, almost obcordate. Fruit sweet or bitter, nearly black; stone smooth.

Distribution Cultivated in the North-Western Himalayas up to an altitude of 8,000 ft., especially in Kashmir.

Uses and properties The fruit is well known and much valued as a dessert. The seed-kernel contains amygdalin (*4*).

4. Prunus cerasus Linn.

Fl. Brit. Ind., II, 313.

(Cherry Tree, Dwarf Cherry, Sour Cherry, Wild Cherry)

Vernacular names: ARABIC—Farasia, Jerasayya, Kerasya; PERSIAN—Alubalu, Alubuali, Kilas; PUNJAB—Gilas, Olchi; UNITED PROVINCES—Alubalu; URDU—Alubalu.

Botanical characters A deciduous shrub or a small tree producing many root-suckers. Leaves erect, firm, shining, obovate, acuminate, crenate-serrate, glabrous beneath; petiole short. Flowers fascicled, long-pedicelled, appearing with the leaves; flowering buds leafy. Calyx-tube campanulate, not constricted at the top; lobes crenate. Petals white or pink, erect, stiff, tip rounded. Fruit globose, light-red to nearly black, acid or sweet; stone smooth.

Distribution Cultivated in the Himalayas of the Punjab and North-West Frontier Province up to an altitude of 8,000 ft.

Uses and properties The fruit is edible; the kernel is believed to be a nervine tonic, and is used for flavouring liqueurs in Europe. The seed-kernels (*5*) as well

as the leaves (*4*) have been found to contain the cyanogenetic glucoside amygdalin.

5. Prunus mahaleb Linn.

Fl. Brit. Ind., II, 312

Vernacular names: ARABIC—Mahalib; BOMBAY—Gahula, Gavala; PERSIAN—Paivandi-miryam; SANSKRIT—Priyunger; SIND—Mahalib; URDU—Khewati.

Botanical characters

A small much-branched shrubby tree. Leaves ovate, shortly acuminate, crenate. Flowers white, fragrant, in peduncled corymbose racemes. Drupe ¼ in. long, ovoid, often mucronate.

Distribution

A Native of Central Asia and Central Europe, probably also occurring in the north-west of India; cultivated in Baluchistan.

Uses and properties

The scented kernels are sold in the bazars of North-West India.

The leaves and stems are thought to have insecticidal properties. The seeds are stated to contain amygdalin (*6*) and, when chewed, have a strong odour of hydrocyanic acid (*7*).

6. Prunus padus Linn.

Fl. Brit. Ind., II, 315.

(Bird Cherry)

Vernacular names: HAZARA—Kala-kat; HINDI—Jamana; JAUNSAR—Jamnoi, Jamoi, Jamroi; KASHMIR—Jaman, Zamb-chule; KUMAON—Bombaksing, Bombali, Jamana, Jamun, Jamuna; LEPCHA—Hlosa-hlotkung; NEPAL—Arupatti, Likharu; NORTH-WESTERN HIMALAYAS—Jamoi, Jammu, Jamun; PUNJAB—Bart, Chule, Dudla, Gidar-dak, Jammu, Jamna, Jamun, Kala-kat, Krun, Paras, Zam, Zambu, Sum.

Botanical characters

Small to medium-sized deciduous tree. Leaves red in autumn, 4–6 in. long, oblong-obovate or -lanceolate, acuminate, with a cordate base, sharply closely serrulate; nerves 10–20 pairs; petiole often eglandular. Flowers ¼–⅓ in. diam., white, in drooping racemes 3–10 in. long. Stamens 30–40. Drupe ⅓ in. diam., globose, red, turning to dark-purple or black, acid; stone thick, rugged.—Wallich's name of *cornuata* is in reference to a diseased (by insects) condition of the ovary, which becomes elongate, curved and fusiform as in *P. puddum* Roxb. *ex* Wall.

Distribution

A native of the temperate Himalayas from Kurrum at altitudes of 4,000 ft. to Sikkim and Bhutan between 8,000 and 12,000 ft.

Constituents

According to earlier workers, almost all parts of the plant (leaves, flowers, seeds, and bark) contain the cyanogenetic glucoside amygdalin (*4*). Recent work shows that the glucoside found in the twigs is prunasin (mandelonitrile glucoside), which on hydrolysis yields hydrocyanic acid, benzaldehyde, and glucose (*8*).

7. **Prunus persica** (Linn.) Stokes

P. persica Benth. & Hook. *f.*, Fl. Brit. Ind., II, 313.

(Peach, Nectarine)

Vernacular names: ARABIC—Khuj, Persik; CHAMAN—Zargah; GARHWAL—Khirola; HINDI—Aru; KANARESE—Pichchisu-hannu, Pichesu; KUMAON—Aru; LEPCHA—Takpo; MASTUNG—Shaftalu; NEPAL—Aru; PERSIAN—Aru, Shuftalu; PISHIN—Shalil: PUNJAB—Aor, Aru, Arui, Beimi, Bem, Bembi, Chimmanu, Katherti, Sunnu, Tsunu; PUSHTU—Ghargashtai, Ghwareshtai, Mandala, Mandata, Shaftalu; QUETTA—Shalil; RAJPUTANA—Aru; SUTLEJ—Beim, Rek; UNITED PROVINCES—Aru, Rek; URDU—Adu, Aru; URIYA—Fishu.

Botanical characters

A large deciduous shrub or a small tree. Leaves $2\frac{1}{4}$–4 in. long, oblong-lanceolate, serrate; petiole glandular or not, shorter than the leaf-breadth; stipules fimbriate. Flowers sessile or shortly pedicelled, pink, appearing before or sometimes with the leaves. Drupe downy, succulent; stone deeply and irregularly furrowed.—Peach is a form with downy pericarp, and nectarine with a glabrous one.

Distribution

This plant is widely cultivated in India, especially in the north-west where some of the finest varieties of the fruit are grown. It also occurs in a naturalized state in the north-west up to an altitude of 10,000 ft. The fruit is also cultivated extensively in the plains of the Punjab and North-West Frontier Province, and also in the Nilgiris between altitudes of 5,000 to 7,000 ft. The fruit ripens according to altitude from May to October.

Uses and properties

The leaves are said to have insecticidal and vermicidal properties. The kernel, flower, leaf, and bark have the peculiar odour and taste of bitter almonds, and are stated to yield hydrocyanic acid. The flowers are stated to have purgative and anthelmintic properties, and fatal cases of poisoning are said to have occurred in children from their use (*9*). The seed-kernels contain amygdalin (*10*), and yield about 0·7 per cent of an essential oil, which consists chiefly of hydrocyanic acid, benzaldehyde, and benzaldehydecyanhydrin (*11*).

8. **Prunus puddum** Roxb. *ex* Wall.

Fl. Brit. Ind., II, 314.

(Wild Cherry of the Himalayas)

Vernacular names: BURMA—Panni; GUJERATI—Padmak, Padma-kathi; HINDI—Padam, Paddam, Padma-kashtha, Pajia, Paya, Phaja; JAUNSAR—Phaja; KUMAON—Padam, Paddam, Paiya, Puya; LEPCHA—Kongki; MARATHI—Padmaka, Padma-kastha; NEPAL—Paiyung; PUNJAB—Amalguchh, Chamiari, Paddam, Paja, Pajia, Pajja; SANSKRIT—Padmaka Padmaksh.

Botanical characters

A moderate-sized to large tree of brilliant appearance when in flower, Leaves 3–5 in., ovate- or oblong-lanceolate, long-acuminate, sharply

often doubly serrate ; petiole 2–4-glandular. Flowers solitary, fascicled or umbelled, 1 in. diam., pink or white, appearing before the leaves. Calyx-tube narrowly campanulate. Petals obovate or linear-oblong. Drupe $\frac{1}{2}$–$\frac{3}{4}$ in. long, oblong or ellipsoid, obtuse at both ends ; flesh scanty, reddish or yellowish, acid ; stone wrinkled and furrowed.

Distribution

Found wild in the temperate Himalayas from Garhwal at altitudes of 3,000 to 6,000 ft. to Sikkim and Bhutan from 5,000 to 8,000 ft. ; also met with in the hill stations of Kodaikanal and Ootacamund in South India.

Uses and properties

Duthie (*12*) states that the fruits of this tree are used for making cherry brandy. The leaves and kernels are said to contain a substance which yields hydrocyanic acid (*13*). The bark is also stated to contain a hydrocyanic-acid-yielding substance, and the smaller branches are used in indigenous medicine as a substitute for hydrocyanic acid (*14*).

9. **Prunus undulata** Buch.-Ham.

Fl. Brit. Ind., **II**, 316.

Vernacular names : ALMORA—Aruwa ; GARHWAL—Aria, Gadharu.

Botanical characters

A medium-sized deciduous tree with rounded crown. Leaves usually 2–3 in., membranous, oblong-lanceolate, acuminate, crenate-serrate, glabrous ; nerves 8–10 pairs ; petiole usually eglandular. Raceme slender. Flowers $\frac{1}{6}$ in. diam., white ; stamens 15–20. Drupe ovoid, red, becoming black when ripe ; stone with a thin wall, smooth, $\frac{1}{4}$ in.

Distribution

Found in the temperate Himalayas from Kumaon at altitudes of 6,000 to 8,000 ft. to Sikkim and Bhutan from 8,000 to 12,000 ft. ; also in the Khasia Hills.

Toxicity

Wallich, quoted by Hooker (*15*), observes that the foliage of this plant is poisonous to goats. The leaves and fruits contain substances which yield hydrocyanic acid (*13*).

2. **PYGEUM** Gaertn.

(Etymology obscure.)

Botanical characters

Evergreen trees or shrubs. Leaves simple, persistent, usually entire, sometimes with a pair of pitted glands near the base of the blade ; stipules minute, fugacious. Flowers small, racemose, sometimes unisexual by the suppression of the ovary. Calyx-tube obconic, urceolate or campanulate, deciduous ; limb 5–15-toothed, often unequally. Petals minute, 5–6 in the 5–6-toothed calyx, 0 in the 10–15-toothed, usually villous or tomentose, often indistinguishable from the calyx-lobes. Stamens 10–50, in one or more series at the orifice of the calyx-tube. Carpel solitary at the base of the calyx-tube, with 2 collateral pendulous

ovules ; style terminal. Fruit a transversely oblong, obscurely didymous, rarely subglobose drupe ; pericarp thin, dry or fleshy.

Distribution

Mostly in the tropical regions of Asia.

Constituents

The bark of some foreign species, *e.g.*, *P. latifolium* Miq. and *P. parviflorum* Teijsm. & Binn., contains amygdalin (*16*).

Pygeum gardneri Hook. *f.*

Fl. Brit. Ind., II, 321.

Vernacular names : BOMBAY—Daka, Kaula.

Botanical characters

A medium-sized tree, glabrous except the inflorescence. Bark of the branches dotted with white specks. Leaves ovate or ovate-lanceolate, acuminate, 4–6 in., very coriaceous ; basal glands often absent. Racemes 2–4 in., axillary, stout, pubescent ; bracts deciduous. Flowers

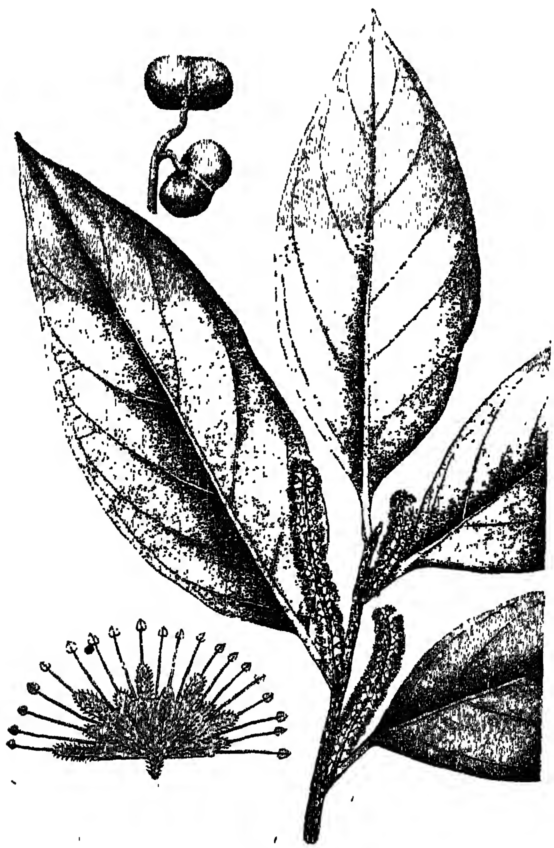

FIG. 85. *Pygeum gardneri* Hook. *f.*

$\frac{1}{4}$ in. diam. Calyx-tube urceolate; limb with 10–12 obtuse, tomentose lobes. Petals 0. Stamens about 20. Ovary glabrous (not hirsute as in Fl. Brit. Ind.), surrounded by a ring of hairs at the base (giving the ovary a hirsute appearance at first sight). Fruit 1–1$\frac{1}{4}$ in., transversely 2-lobed, shining and smooth, apiculate in the sinus at the top.

Distribution

Found in the Western Ghats of Madras and Bombay Presidencies, in the hills of Travancore, Malabar, Nilgiris, Pulneys, the Deccan, Southern Mahratta Country, and Konkon at altitudes above 3,000 ft.; common on the Mahableshwar plateau.

Toxicity

The seeds smell strongly of hydrocyanic acid. The kernel of the fruit is used as a fish poison.

3. PYRUS (Tourn.) Linn.

(The classical name of the pear tree.)

Botanical characters

Trees or shrubs. Leaves deciduous, simple or pinnate; stipules deciduous. Flowers white, red or pink, in terminal cymes or corymbs; bracts subulate or linear. Calyx-tube urceolate, turbinate or obconic; lobes 5, erect or reflexed, persistent or falling off after flowering. Petals 5. Stamens 20 or more; filaments sometimes connate at the base. Carpels 2-5, connate and adnate to the calyx-tube; styles 2-5, free or connate below; stigmas truncate; ovules 2 in each cell. Fruit (a pome) fleshy, having 2–5 parchment-like cells at the centre, each containing 1 or 2 seeds or pips.

Distribution

North temperate and cold regions.

Economic and toxic aspects

Apple (*P. malus* Linn.), pear (*P. communis* Linn.), mountain ash (*P. aucuparia* Gaertn.), etc., belong to this genus. Most of the species of *Pyrus* contain the glucoside amygdalin, which is hydrolyzed by the action of the ferment into hydrocyanic acid (*17*). Some species, such as *P. malus* Linn., have been found to contain the glucoside phloridzin.

KEY TO THE SPECIES

a. Leaves pinnate. Styles entirely free .. .. 1. *P. aucuparia*.
b. Leaves simple. Styles connate below .. .. 2. *P. malus*.

1. Pyrus aucuparia Gaertn.*

Fl. Brit. Ind., II, 375.

(Rowan Tree, Mountain Ash)

Vernacular names: PUNJAB—Battal, Rangrek, Ranthul, Vampu-litsi.

Botanical characters

A small tree, young parts with white cottony tomentum which sometimes persists on the petioles and inflorescence. Leaves pinnate, 4–8 in.;

* Some authors prefer to call it *Sorbus aucuparia* Linn.

leaflets 15–25, $\frac{3}{4}$–$1\frac{1}{2}$ in., linear-oblong obtuse and apiculate, or oblong-lanceolate and acuminate, sharply serrate, entire towards the rounded base, glabrous except at the nerves below. Flowers pink, $\frac{1}{3}$–$\frac{1}{2}$ in. diam., crowded in usually quite glabrous corymbs. Petals orbicular. Styles 2–5, free, woolly at base. Fruit red, globose, $\frac{1}{3}$–$\frac{1}{2}$ in. diam.

Distribution

Occurs in the temperate Western Himalayas from Kashmir to Kumaon at altitudes from 9,000 to 13,000 ft.

Uses and properties

The red globose fruit, which resembles in size and flavour that of the same tree in Europe, is not eaten in India. In certain parts of Europe it is made into a jelly, and also used in the preparation of a liqueur or cordial.

The fresh bark is used in medicine; it is also known to produce irritation of the alimentary mucous membrane and a reflex nervous irritation (*17*).

Constituents

The defatted seeds were found to contain about 0·073 per cent of hydrocyanic acid (*18*).

2. Pyrus malus Linn.

Fl. Brit. Ind., II, 373.

(Apple Tree, Crab-apple Tree)

Vernacular names: ARABIC—Tuffah, Tyffah; BENGAL—Seb; HINDI—Seb, Seo, Sev; KANARESE—Sebu, Sevu; KUNAWAR—Palu; LADAKH—Kushu; PANGI—Chur; PERSIAN—Seb, Sef, Sib, Sir; PUNJAB—Se, Seb, Seo; PUSHTU—Mana, Manra; SANSKRIT—Badara, Mushtinanan, Seba, Seva, Sevam, Sinchitika; SIND—Seb, Suf; UNITED PROVINCES—Seb, Seo, Sheo.

Botanical characters

A tree rarely exceeding 30 ft.; young shoots, lower side of leaves and inflorescence clothed with thin white silky tomentum. Leaves 2–3 in., ovate, shortly acuminate or acute, crenate. Flowers $1\frac{1}{2}$–2 in. diam., pink. Calyx densely tomentose. Styles 5, united below the middle. Fruit large, globose, very shortly pedicelled, intruded at both ends, crowned by the persistent calyx-lobes.

Distribution

Largely cultivated in the Himalayas, the Punjab, Sind, North-West Frontier Province, Central India, and the Deccan; also found wild in the North-Western Himalayas.

Uses and properties

The apple is a well-known fruit. Its Indian stock is of indifferent quality in the plains, but improves in the Himalayas. According to Pammel (*17*), cases of poisoning occasionally occur when animals are allowed to browse upon the wilting leaves of the apple tree. The root is said to have narcotic properties (*19*).

Constituents

The leaves yield about 1 per cent of phloridzin (*20*); the bark also contains this glucoside (*4*). The seed-kernels have been shown to contain amygdalin (*10*).

Phloridzin produces a unique form of glycosuria. It forces the kidneys to excrete dextrose, thus producing polyuria and acetonuria.

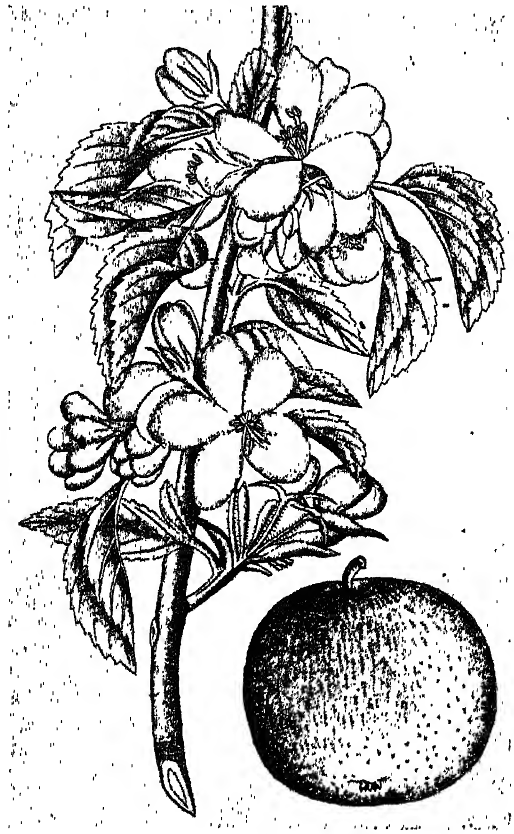

FIG. 86. *Pyrus malus* Linn.

The loss of sugar from the blood leads to its production from the katabolism of the protein of the tissues, thus greatly increasing the excretion of nitrogen and other products in the urine, etc. These phenomena are of great scientific but no therapeutic importance (*21*). When given in large quantities by mouth, phloridzin sometimes produces diarrhoea in animals, but apart from this its only effect is glycosuria, which also follows its injection subcutaneously or intravenously. Glycosuria can be maintained for an indefinite period if the

administration of phloridzin is continued, but animals recover rapidly when the drug is stopped. The glucoside is probably excreted unchanged in the urine.

4. RUBUS (Tourn.) Linn.

(The Latin name for the bramble, derived from *ruber*—red; referring to the colour of the fruit in some species.)

Botanical characters

Creeping herbs or erect or sarmentose shrubs, almost always prickly. Leaves simple or compound; stipules free or adnate to the petiole. Flowers white or red, in terminal and axillary corymbose panicles, rarely solitary. Calyx-tube broad; lobes 5, persistent. Petals 5. Stamens numerous. Carpels numerous, superior, on a convex receptacle; style filiform, subterminal; ovules 2, collateral. Fruit globose, formed by the combination of numerous, succulent, 1-seeded drupelets.

Distribution

Abundant in the Northern Hemisphere, rare in the Southern Hemisphere.

Uses

This genus includes the brambles, blackberry, and raspberry of Britain. The fruits of several species, which grow wild in India, are edible.

Rubus moluccanus Linn.

Fl. Brit. Ind., II, 330.

Vernacular names: KUMAON—Katsol; LEPCHA—Sufokji; NEPAL—Bipem-kanta.

Botanical characters

An extensive scrambling shrub, armed with short curved flattened scattered prickles. Leaves as broad or broader than long, 2–10 in. diam., usually deeply cordate, broadly ovate or orbicular, palmately obtusely or acutely 3–7-lobed, toothed, smooth scabrid or rugose above, beneath clothed with grey or yellow wool or pubescence; petiole 2–4 in. long; main nerves often prickly beneath; stipules oblong, toothed, pinnatifid, laciniate or pectinate. Panicles axillary and terminal. Flowers ½–1 in. Calyx villous and silky; lobes lanceolate or ovate, acute, entire or with pectinate margins. Petals white, shorter than the calyx-lobes. Fruit globose, succulent, of many scarlet drupelets; receptacle villous.—This is one of the most variable species of *Rubus*, and some of the varieties of Fl. Brit. Ind. have been raised to specific rank in the local floras.

Distribution

Common in many parts of the Central and Eastern tropical and temperate Himalayas from Kumaon to Sikkim at altitudes of 3,000 to 7,000 ft. It occurs also in Assam and in the Khasia Hills at altitudes of 3,000 to 5,000 ft. It is further found in the Western Ghats from

Mahableshwar southwards to Travancore, Nilgiri and Pulney Hills, and rarely in the Eastern Ghats.

FIG. 87. *Rubus moluccanus* Linn.

Uses and properties

The red, globose, succulent fruits of this plant, like those of many other species of *Rubus*, are edible. According to Rumphius, the leaves are abortifacient and possess powerful emmenagogue properties (*14*).

5. SPIRAEA Linn.*

(From the Greek *speiraia*, from *speira*—a spire, something twisted; in allusion to the flexible branches.)

Botanical characters

Erect, unarmed shrubs or perennial herbs. Leaves simple or compound; stipules free or adnate to the petiole, rarely 0. Flowers

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* The genus as defined here is nowadays usually divided into a number of genera, the herbaceous members falling under *Ulmaria* and *Aruncus*, and the shrubby species under *Spiraea*, *Sorbaria*, etc.

crowded in racemes, corymbs or panicles, white or red. Calyx persistent; lobes 4–5. Petals 4–5. Stamens 20–60, free or united below. Carpels 5 or more, free or united below; styles subterminal; ovules 2 or more. Follicles 5 or more, few-seeded.

Distribution — Temperate and cold regions of the Northern Hemisphere.

Uses and properties — Members of this genus are hardly of any economic importance. Some of the Indian species, such as *S. bella* Sims, are ornamental and are cultivated in gardens. The Chinese *S. cantoniensis* Lour. is also occasionally cultivated. Both are shrubs; the former with pink, rarely white flowers, and the latter with white flowers.

The different parts of some species of *Spiraea* are stated to yield hydrocyanic acid.

KEY TO THE SPECIES

a. Herb. Leaves 2- or 3-pinnate. Leaflets ovate, usually in threes 1. *S. aruncus.*

b. Shrub. Leaves simply pinnate. Leaflets narrowly lanceolate 2. *S. sorbifolia.*

1. Spiraea aruncus Linn.*

Fl. Brit. Ind., II, 323.

Botanical characters — A shrub-like dioecious herb, 2–4 ft. high. Leaves 2- or 3-pinnate, 6–12 in.; leaflets usually in threes, ovate, narrowed upwards into a tail-like tip, 1–2 in. or longer, acutely doubly serrate; stipules obsolete. Flowers white, $\frac{1}{4}$ in. diam., in long panicled pubescent racemes. Carpels 6–8. Follicles glabrous, shining.

Distribution — Found in the temperate Western and Central Himalayas.

Constituents — The leaves, twigs, and roots are stated to yield hydrocyanic acid (*22*). The seeds are stated to contain a saponin (*23*).

2. Spiraea sorbifolia Linn.

Fl. Brit. Ind., II, 324.

Botanical characters — A tall shrub, with simply pinnate leaves 8–12 in. long, leaflets 13–19, 2–4 in., sessile, narrowly lanceolate, acuminate, doubly serrate; stipules linear-subulate. Flowers white, $\frac{1}{4}$ in. diam., in terminal panicles 6–12 in. long. Carpels 5, ripe oblong.

* Some authors prefer to call it *Aruncus sylvester* Kostel.

Distribution

Found in the temperate Western Himalayas from Hazara to Kumaon at altitudes of 4,000 to 11,000 ft.

FIG. 88. *Spiraea sorbifolia* Linn.

Constituents

The herb and flowers are stated to yield hydrocyanic acid (24).

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Family XXXI.—CRASSULACEAE

(Orpine and Houseleek Family)

Botanical characters

Herbs or undershrubs, usually succulent. Leaves usually simple but rarely divided in *Bryophyllum* and *Kalanchoe*; stipules 0. Flowers usually cymose, sometimes paniculate or racemose, 2-sexual or very rarely unisexual. Calyx 4–5-fid, more rarely 6–8-fid, free. Petals as many as sepals, free or connate. Stamens hypogynous or epipetalous, as many as or twice the petals. Carpels usually as many as the petals, with a hypogynous gland or scale at the base of each, free or connate below, narrowed upwards into the styles. Fruit usually a group of follicles dehiscing down the inner faces, many-seeded, sometimes 1–few-seeded. Seeds small, albuminous.

Distribution

A small family spread all over the globe, rare in Australia and South America, abundant in South Africa, and general in the Northern Hemisphere.

Economic and toxic aspects

A large number of plants of this family have smooth succulent leaves, and are able to grow in places where water is at times scarce. Life plant [*Bryophyllum pinnatum* (Lam.) Kurz, syn. *B. calycinum* Salisb.] is remarkable for forming new plants at the crenatures of the leaves when these are laid on damp ground. Cases have been observed when young plants are developed even in botanical specimens in the drying press. A few of the species are cultivated for ornamental purposes, for example, *Rochea coccinea* DC. of the Cape of Good Hope, whose flowers have narcotic properties.

Vulnerary, refrigerant, sedative, antiscorbutic, and diuretic properties are ascribed to some of the members of this family.

Some species of *Cotyledon*, especially *C. ventricosa* Burm. *f.* and *C. wallichii* Harv., are reported as poisonous in South Africa, and are concerned in the production of a disease called "krimpsiekte", "nenta" or cerebrospinal meningitis, especially in small stock (*1*); this is characterized by affections of the central nervous system. Cotyledontoxin, a toxic constituent, is reported from *C. leucophylla* Sm. and is possibly present in a few other species of the genus. Cotyledontoxin is a neutral nonalkaloidal and nonglucosidal amorphous substance without any nitrogen (*2*). A partial destruction of this poisonous principle takes place when it is boiled in the presence of oxygen; it is, however, fairly thermostable in the absence of air (*3*). Three species of *Cotyledon* are found in the Himalayas and in Western Tibet, but nothing is so far known regarding their properties.

A toxic acrid juice is found to occur in some species of *Sedum*, *e.g.*, *S. acre* Linn. (stonecrop), which is stated to contain the glucoside rutin and an alkaloid. *S. telephium* Linn. (orpine) is stated to contain an amorphous glucoside (*4*).

KALANCHOE Adans.

(The Chinese name of one of the species.)

Botanical characters

Erect stout usually fleshy perennial herbs. Leaves opposite or the upper alternate. Flowers large, usually yellow, in many-flowered sub-paniculate cymes. Calyx 4-partite or 4-fid. Corolla with a flask-shaped tube and spreading 4-fid limb, much exceeding the calyx, persistent. Stamens 8, 2-seriate, adnate to the corolla-tube. Hypogynous scales 4. Carpels 4, adnate to the base of the corolla-tube, attenuated into long styles. Follicles 4. Seeds numerous, oblong-ellipsoid, with 8–15 longitudinal ribs.

Distribution

Chiefly in the tropical regions and in South Africa; several species occur in the tropical regions of Asia; one species is found in Brazil.

Kalanchoe spathulata (Poir.) DC.

Fl. Brit. Ind., II, 414.

Vernacular names: HINDI—Haiza-ka-patta, Rungru, Tatara; KUMAON—Bakal-patta, Pat-kuari; NEPAL—Hathokane; PUNJAB—Haiza, Rungru, Tatara.

Botanical characters

A glabrous succulent perennial; stem 1–4 ft. high. Leaves spathulate-oblong, crenate; upper distant and becoming very narrow, often 3–4 in. long by ½ in. broad, sometimes 3-foliolate, frequently sessile; lower petiolate. Lower panicle-branches usually opposite; lowest bracts subsimilar to upper leaves. Flowers clear yellow. Calyx divided nearly to the base, in fruit often ⅜ in. wide; segments elongate, triangular from a broad base.

Distribution

Found in the tropical and subtropical Himalayas from Kashmir to Bhutan, generally between 1,000 and 4,000 ft., but near Simla it is found up to an altitude of 6,000 ft. Also found in the Deccan and Southern Mahratta Country.

Toxicity

The expressed juice of the bitter variety is a drastic purgative. It is poisonous to goats and is not eaten by cattle (*5*). The leaves are stated to be poisonous to insects.

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Family XXXII.—DROSERACEAE

(Sundew Family)

Botanical characters

Herbs, catching insects by means of glandular sticky hairs or by means of petioled leaves with automatically closing laminae. Leaves radical or alternate. Flowers hermaphrodite, regular. Calyx persistent, 4–5- (rarely 8-) partite, or the sepals distinct. Petals and stamens as many as the sepals, hypogynous or nearly so. Ovary nearly free, globose or ovoid, 1–3-celled ; styles 2–5 ; stigmas capitate, fimbriate or bifid ; ovules numerous, on parietal placentas. Capsule membranous, 2–5-valved, many-seeded. Seeds with fleshy albumen.

Distribution

Found in nearly all temperate and tropical regions in boggy or marshy places, except the Pacific Islands and the arctic regions.

Economic and toxic aspects

Plants of this family are, as a rule, acrid, bitter, and astringent. If placed in milk they rapidly curdle it, probably owing to the presence of organic acids and enzymes. The most important genus is *Drosera*, commonly called the sundew, the tentacles of which secrete a viscid fluid ; the insects alighting on the leaves become entangled in this fluid and are digested.

Some species of *Drosera* are alleged to be injurious to sheep in Australia. Writers on Indian plants have recorded that cattle avoid species of *Drosera*. From the size and the restricted distribution of the few Indian species (three in all) they, with the possible exception of *D. peltata* Sm. *ex* Willd., var. *lunata* Clarke, are not likely to be important from the toxicological point of view, even if they are poisonous to livestock.

Constituents

Some species of *Drosera* have been found to contain colouring matters, organic acids, and proteolytic enzymes in the secretions of their leaves (*1*). A few of the foreign species are reported to contain hydrocyanic acid (*2*). A toxic acrid juice is contained in certain species of some foreign genera, *e.g.*, *Dionaea* and *Nepenthes*.

DROSERA Linn.

(From the Greek *droseros*—covered with dew ; referring to the dew-like shining excretions on the tips of the glandular leaf-hairs.)—Sundew.

Botanical characters

Perennial herbs, scapigerous or with a leafy stem. Leaves rosulate or cauline, the glandular hairs attracting and securing small insects which they assimilate. Flowers white or rosy. Calyx 4–8-partite, withering persistent. Petals as many, withering persistent. Ovary free,

1-celled. Capsule loculicidally 2–5-valved. Seeds obovoid-ellipsoid; testa black, smooth, reticulate.

Distribution Tropical and temperate regions; many species occur in Australia.

KEY TO THE SPECIES

a. Leaves all radical, rosulate, cuneate-spathulate	..	1. *D. burmanni.*
b. Leaves cauline, alternate, semilunate, peltate	..	2. *D. peltata*, var. *lunata.*

1. Drosera burmanni Vahl

Fl. Brit. Ind., II, 424.

Vernacular name: HINDI—Mukha-jali.

Botanical characters A pretty plant with a very close compact rosette of cuneate-spathulate leaves $\frac{1}{2}$–$1\frac{1}{2}$ in. long. Scapes 1–3, 2–8 in. high, glabrous. Flowers rose-pink or white, in secund racemes occupying the upper fourth of the scapes only; pedicels glabrous. Styles 5, undivided.

Distribution Found throughout India from Ceylon and Bombay to the base of the Himalayas.

Toxicity This plant has powerful rubefacient properties due to the presence of napthaquinone (*3*), which is irritant.

2. Drosera peltata Sm. *ex* Willd., var. lunata Clarke

Fl. Brit. Ind., II, 425.

Vernacular names: HINDI—Mukha-jali; PUNJAB—Chitra.

Botanical characters An erect pretty plant with slender stems up to 12 in. high, often branching. Leaves alternate, about $\frac{1}{4}$ in. across, half-moon-shaped, peltate, long-petioled; rosulate leaves early deciduous. Flowers white, $\frac{1}{4}$ in. diam., in terminal branching racemes. Calyx-segments minutely toothed. Styles 3; stigma minutely fringed.—The plant gives a red stain on the paper when being dried.

Distribution Found in the hilly regions throughout India up to an altitude of 10,000 ft. in the Himalayas, and 8,000 ft. in the Nilgiris.

Uses and properties The leaves of this curious insectivorous plant when crushed and mixed with salt are used as a blistering agent in Kumaon. The same practice prevails in Kunawar without, however, the use of salt (*4*).

Allied plant *D. indica* Linn., which has weak and decumbent stems, linear alternate leaves, leaf-opposed racemes, and 3 styles bifid to the base, is found frequently in Western India. It is likely that it has the same

properties as the above two plants. A preparation made by maceration of this plant is used for application to corns.

FIG. 89. *Drosera peltata* Sm. *ex* Willd.

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Family XXXIII.—COMBRETACEAE

(Myrobalan Family)

Botanical characters

Trees or shrubs, often climbing. Leaves alternate, subopposite or opposite, simple, entire, exstipulate, often with small peltate scales beneath or dots due to cystoliths. Flowers hermaphrodite, rarely unisexual or polygamous, generally small, usually in spikes or racemes which are often panicled; bracteolate. Calyx-tube adnate to the ovary and produced above it; limb 4–5-lobed. Petals 0 or 4–5, inserted on the calyx. Stamens as many as the calyx-lobes or twice and 2-seriate, on the calyx. Ovary completely inferior, 1-celled; style and stigma simple. Fruit coriaceous or drupaceous, usually indehiscent, ovoid, angular or very often winged. Seed 1, exalbuminous.

Distribution

In the tropics of the whole world.

Economic aspects

Many of the members of this family, especially the terminalias, have astringent properties due to the presence of large quantities of tannins; and the barks and fruits are often used medicinally. *Quisqualis indica* Linn. is commonly cultivated in Indian gardens. Some species of *Terminalia* yield valuable timber, and myrobalans, the fruits of *T. chebula* Retz. and *T. bellirica* (Gaertn.) Roxb., are important articles of trade. The dried fruit of the former contains a very valuable tanning material, which is commonly used in India. The gum of *Anogeissus latifolia* Wall. is used extensively in calico printing, and the wood is valued for its great strength and toughness.

Toxic aspects

Some of the foreign plants of this family, *e.g.*, *Combretum erythrophyllum* Sond. and *C. grandiflorum* G. Don, are said to be used as arrow poisons. *Terminalia bursarina* F. Muell., a foreign plant, is stated to cause a peculiar type of nervous disorder or fits in sheep after feeding on its foliage (*1*).

TERMINALIA Linn.

(From the Latin *terminalis*—extremity; from the leaves being crowded together at the ends of the twigs in some species.)

Botanical characters

Large trees with subopposite or alternate leaves sometimes clustered at the ends of the twigs and often bearing large glands on the petiole or near the base of the midrib beneath. Flowers small, green or white, in simple or panicled spikes, hermaphrodite or the upper flowers of the spike sometimes male. Calyx-tube produced above the ovary with a campanulate mouth; limb of 5 short valvate triangular lobes, deciduous.

Petals 0. Stamens 10 in 2 series; epigynous disc within them densely hairy. Ovules 2–3. Fruit ovoid, very various in size, smooth or angular or winged with 2–5 wings, indehiscent, coriaceous.

Distribution

In the tropical regions of the whole world.

Constituents

The barks and fruits of the terminalias are very rich in tannins, some barks containing as much as 35 per cent (*2*).

KEY TO THE SPECIES

a. Leaves alternate, clustered at the ends of twigs. Spikes simple. Fruit subglobose, grey-tomentose ..	1. *T. bellirica*.
b. Leaves not clustered at the ends of twigs. Spikes panicled. Fruit ellipsoidal or obovoid, glabrous	2. *T. chebula*.

1. Terminalia bellirica (Gaertn.) Roxb.

T. belerica Roxb., Fl. Brit. Ind., **II**, 445.

(Bahera Nut, Bastard Myrobalan, Bedda Nut, Belleric Myrobalan)

Vernacular names : ARABIC—Balilaj, Batilaj, Beleyluj; ASSAM—Bauri, Hulluch; BENGAL—Bahera, Baheri, Bahira, Bahura, Behera, Bhairah, Bohera, Bohora, Boyra, Buhuru; BHIL—Yhera; BURMA—Bankha, Pangan, Phanga, Phangasi, Phankhasi, Ruhira, Thitsein, Tissein; CENTRAL PROVINCES—Bahera, Behara, Behera, Bihara, Bjaira, Toandi; DECCAN—Babra, Balda, Balra, Bairda, Batra, Bherda, Bulla, Yehala; GARO—Chirorae; GOND—Bunjir, Tahara, Taka; GUJERAT—Baheda, Bahedo, Behaza, Beheda, Behedan, Bero, Sag; HINDI—Bahera, Behara, Behra, Bhaira, Bharla, Buhura, Bulla, Sagona; HYDERABAD—Ahera, Jhera; KANARESE—Santi, Tare, Tari, Vibhita, Vibhitaka; KOLAMI—Lupung; KONKANI—Gotting, Gutting; KUMAON—Bahera; LEPCHA—Kanom; MALAYLAM—Tani, Thani, Tusham; MARATHI—Bahera, Baira, Balra, Beda, Beharda, Behasa, Beheda, Bherda, Bhirda, Hela, Goting, Sagwan, Vavara, Vela, Yehela-behada, Yela; MERWARA—Bahera; NEPAL—Barra; PERSIAN—Balela, Balilah, Belayleh; PUNJAB—Bahera, Bahira, Balela, Bayrah, Behera, Bhera, Birha; SANSKRIT—Aksha, Baheruha, Baheruka, Bahira, Bibhitaka, Tusha, Vibhitaka, Vibhitaki, Vipitaka; SANTAL—Lopong; SIND—Bayrah; TAMIL—Tani; TELUGU—Bhutavasamu, Tani, Tandra, Vibhitakamu; TULU—Dandi, Tandi; UNITED PROVINCES—Bahera, Beharia, Buhera; URDU—Behera; URIYA—Bahada, Thara.

Botanical characters

A large deciduous tree 60–80 ft. high. Leaves 3–8 in., broadly elliptic or elliptic-obovate, cuneate at base, clustered at the ends of the branchlets (alternate and distant on some growing twigs), generally punctate on the upper surface; petiole 1–4 in. Spikes solitary, axillary, simple. Flowers pale greenish-yellow, with an offensive odour, upper flowers of the spike male, lower hermaphrodite. Drupe ½–1 in. diam., subglobose, suddenly narrowed into a short stalk, grey-tomentose, obscurely 5-angled when dried; stone hard and pentagonal and contains a sweet oily kernel having 3 prominent ridges from base to apex.

Distribution

Common in the plains and lower hills throughout India with the exception of the arid tracts in the west.

The fruit is exported in large quantities under the name of myrobalan, and is largely employed in India for dyeing and tanning and for medicinal purposes. The unripe fruit is astringent while the ripe one is used as a purgative. The dried pulp of one full-grown ripe fruit is sufficient to cause purgation (*3*). *Uses and properties*

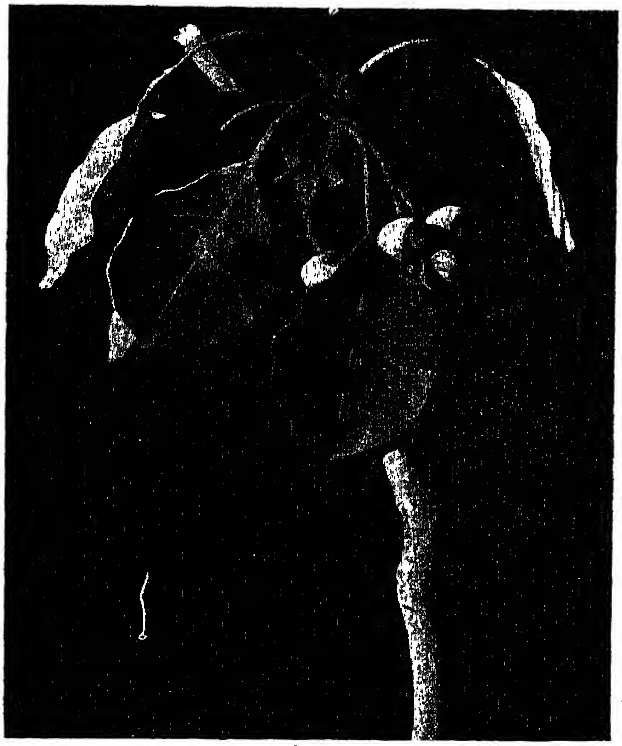

FIG. 90. *Terminalia bellirica* (Gaertn.) Roxb.

When fresh it is eaten by goats, sheep, cattle, deer, and monkeys. The kernel is eaten by human beings and tastes like a filbert, but it is said to produce intoxication when eaten in excess. The evidence regarding the narcotic properties of the kernel is, however, conflicting, but at least two cases of accidental poisoning from eating the fruit have been reported. In one (*4*), three boys showed symptoms of poisoning; all however recovered. In the other (*5*), a woman and two children were poisoned; one of them a weakly girl of eight or nine years died, but the other two recovered. The symptoms observed were nausea and vomiting followed by narcosis. Some suggest that only the large-fruited

variety is poisonous; others state that they have eaten both kinds freely without experiencing any narcotic effect, but that if water were taken after eating them giddiness and a sense of intoxication are experienced.

The plant has been reported as a fish poison (*6*), but there is no record of such use in India.

Constituents The fruits contain 5 to 17 per cent of tannin (*2*).

2. Terminalia chebula Retz.

Fl. Brit. Ind., II, 446.

(Black Myrobalan, Chebule, Chebulic Myrobalan)

Vernacular names: ASSAM—Hilikha; BENGAL—Hara, Haritaki; BHABHAR—Harar; BURMA—Pangah; CENTRAL PROVINCES—Harra, Hirdi; DECCAN—Halra, Harda, Harla; GARHWAL—Haira; GOND—Harro, Hir, Horda, Karka, Majoka; GUJERATI—Hirdo; HINDI—Har, Harara, Harra; KANARESE—Alale, Anile, Arale, Harade, Haritaki; KOLAMI—Kola; KONKANI—Ordo; LEPCHA—Salim-kung, Silim; MALAYALAM—Divya, Katukka, Kayastha, Putanam; MARATHI—Habra, Hirada, Hirda; NEPAL—Harra, Herro; PUNJAB—Halela, Har, Harrar, Hurh; SANSKRIT—Abhaya, Haritaki; SANTAL—Rol; SIKKIM—Hana, Silim-kung; SIND—Har; TAMIL—Kadakkai, Kadukkai, Vayadaram; TELUGU—Haritaki, Karanka, Karakkaya, Nalla-karaka, Resaki, Sringi-tiga; TULU—Anile; UNITED PROVINCES—Har, Haraira, Harara; URAN—Hadra; URDU—Haejarad; URIYA—Horida, Horitoki, Jonghi-horida, Karedha.

Botanical characters A moderate-sized, sometimes large deciduous tree. Leaves not clustered, often subopposite, 4–7 in., ovate or elliptic, usually acute, not accuminate, rounded at the base; petiole 1 in., often with glands at its summit. Spikes terminal, often panicled. Flowers dull-white, with an offensive smell, all hermaphrodite. Drupe $\frac{3}{4}$–$1\frac{1}{4}$ in. long, glabrous, ellipsoidal or obovoid from a broad base, yellowish-green, more or less 5-ribbed when dry due to the 5-ribbed endocarp.—In the Flora of British India six varieties of this species are recognized.

Distribution Abundant in Northern India from Kangra to Bengal and southwards to the Deccan tablelands at altitudes of 1,000 to 3,000 ft. In the Madras Presidency it is common in deciduous forests. In Bombay it is common in the higher forests on or near the Ghats, and is very abundant in the forests of the highland of Satpuras and above the Ghats in Belgaum and Kanara.

Uses and properties The dried fruit is the chebulic or black myrobalan of commerce, yielding one of the most valuable of Indian tanning materials. The fruit is extolled by ancient Hindu physicians as a powerful alterative and tonic, and with the fruits of *T. bellirica* (Gaertn.) Roxb. and *Emblica officinalis* Gaertn. (*Phyllanthus emblica* Linn.) it forms one of the ingredients of the well-known laxative and tonic preparation 'triphala' (three fruits). The ancient writers described seven varieties

of these fruits of which only two are at present recognized—the large ripe fruit called 'haritaki' which is largely used in indigenous medicine, and the unripe fruit called 'jangi-haritaki' which is used as a household remedy for curing constipation, after being fried in ghee and powdered. The author of the "Makhzan-al-Adwiya" distinguishes six different stages of maturity. The amount of tannin matter in the fruit is 20 to 40 per cent (*7*), and is variable at different stages of its growth. The bark contains 27 to 35 per cent of tannins (*2*).

The ripe fruits of chebulic myrobalans are commonly used as a purgative, and some varieties are stated to act rather powerfully; the unripe ones are astringent and aperient (*3*).

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Family XXXIV.—MYRTACEAE

(Myrtle and ' Jamun ' Family)

Botanical characters

Trees or shrubs, rarely herbs. Leaves usually opposite, simple, usually entire, often with an intramarginal nerve, usually dotted with pellucid glands, mostly evergreen. Flowers usually regular, hermaphrodite, axillary, solitary or in spikes, cymes, corymbs or heads, often with 2 bracts at the base, white, pink, purple or yellow, never blue. Calyx superior or $\frac{1}{2}$-superior ; limb 4–5–many-fid or -partite, sometimes entire or closed in bud. Petals inserted on a disc surrounding the cavity of the calyx and equal in number to the calyx-lobes, rarely 0, sometimes connate and falling as calyptra. Stamens usually numerous, inserted with the petals in several rows, rarely definite and alternate with the petals ; filaments free or more or less coherent at the base or in bundles opposite the petals. Ovary inferior or $\frac{1}{2}$-inferior, 1- or more- but usually 2-celled, usually with many axile ovules ; style simple ; stigma undivided. Fruit usually crowned with the calyx-limb, either 1-celled and 1-seeded, or 2–many-celled with loculicidal or septicidal dehiscence, or baccate and indehiscent with the cells many-seeded or 1-seeded by arrest. Seeds angular, cylindric or compressed ; testa hard or membranous, sometimes winged ; exalbuminous.

Distribution

Warm countries, especially Australia and tropical America.

Economic and toxic aspects

This family contains a number of plants of economic importance. Guava (*Psidium guajava* Linn.), rose apple (*Eugenia jambos* Linn.), and black plum [*Eugenia cumini* (Linn.) Druce, syn. *E. jambolana* Lam.] are some of the popular fruits. There are also a number of plants yielding oils of commercial value ; some of these are powerful antiseptics and stimulants. (Clove *Eugenia caryophyllata* Thunb.*), a common article of commerce, yields an essential oil which is an excellent antiseptic. Eucalyptus oil from *Eucalyptus globulus* Labill. and from other species of *Eucalyptus* is much used in medicine as an antiseptic, deodorant, and insect repellent. Cajuput oil from *Melaleuca leucadendron* Linn. is an excellent stimulant. The oil of myrtle from *Myrtus communis* Linn. is largely used in perfumery. The unripe fruits of *Pimenta officinalis* Lindl. when rapidly dried form allspice, from which the

* Merrill and Perry (*Memoirs of the Gray Herbarium of Harvard University*, 1939, no. IV, p. 196) suggest *Syzygium aromaticum* (Linn.) Merr. & Perry as the name for this plant.

pimenta oil (allspice oil) is obtained. Pimenta is cultivated in Indian gardens, especially in Bengal, Bihar, and Orissa.

The members of this family are either astringent and tonic or aromatic and stimulant depending upon the predominance of the tannin or the essential oil.

Some species of *Barringtonia* contain saponins, and are used to poison fish. *Careya arborea* Roxb. is another plant used as a fish poison. Some species of *Rhodomyrtus* are regarded as poisonous in Australia; the fruit of *R. tomentosa* (Ait.) Hassk. (downy myrtle, hill guava) of Nilgiris is edible and delicious.

Constituents

Some of the important constituents found in the members of this family are: (*a*) *essential oils* containing *terpenes*, such as pinene, phellandrene, limonene, etc., *oxides*, such as cineole, *alcohols*, such as myrtenol, geraniol, eudesmol, pinocarveol, etc., *phenols*, such as eugenol, chavicol, etc., *aldehydes* or *ketones*, such as aromadendral, valeric aldehyde, piperitone, etc., and *sesquiterpenes*, such as caryophyllene, etc., (*b*) *saponins*, such as those found in *Barringtonia*, *Chydenanthus*, etc., and (*c*) *tannins*, such as those found in *Careya*, *Psidium*, *Eugenia*, *Eucalyptus*, etc.

KEY TO THE GENERA

A. Fruit indehiscent, hard and fibrous or fleshy. Leaves not gland-dotted.
- *a*. Stamens all perfect. Fruit angular, fibrous, 1-seeded ... 1. *Barringtonia*.
- *b*. Outer or inner stamens or both without anthers. Fruit ovoid or globular, fleshy, many-seeded .. 2. *Careya*.

B. Fruit dry, loculicidally splitting at top. Leaves gland-dotted.
- *a*. Flowers capitate or umbelled. Petals entirely fused into a calyptra .. .. .. 3. *Eucalyptus*.
- *b*. Flowers in spikes. Petals 5, spreading. Stamens in 5 bundles opposite the petals and exceeding them .. .. 4. *Melaleuca*.

1. BARRINGTONIA Forst.

(After Daines *Barrington*, 1727–1800, English judge & naturalist.)

Botanical characters

Trees. Leaves alternate, crowded towards the ends of branches, penninerved, not dotted. Flowers in elongated terminal and lateral racemes or interrupted spikes. Calyx-tube scarcely produced above the ovary; lobes 2–4 (rarely 5). Petals 4 (rarely 5), somewhat adnate at the base to the staminal tube. Stamens numerous, connate shortly into a tube at the base, all filaments bearing anthers. Ovary inferior, 2–4-celled, crowned with an annular disc; ovules 2–8 in each cell. Fruit fibrous or somewhat berried, globose, ellipsoid or quadrangular,

crowned with the calyx, indehiscent, 1-seeded. Seeds ovoid or ellipsoid, exalbuminous.

Distribution

In tropical Asia, Africa, Australia, and Polynesia, often near the sea.

Toxic aspects

Saponins occur in several species of *Barringtonia*. At least three species are recorded as fish poisons.

KEY TO THE SPECIES

A. Leaves entire .. .. 2. *B. asiatica*.

B Leaves minutely toothed.

a. Calyx-lobes imbricate. Flowers pink. Fruit quadrangular .. .. 1. *B. acutangula*.

b. Calyx-lobes valvate. Flowers cream-coloured. Fruit ovoid .. .. 3. *B. racemosa*.

1. Barringtonia acutangula (Linn.) Gaertn.

Fl. Brit. Ind., II, 508.

(Indian Oak)

Vernacular names: ASSAM—Hendol; BENGAL—Hidjal, Hijal, Hinjal, Kumia, Samundar-phal; BURMA—Kyaitha, Kyeni, Kyeni-kyibeng; GUJERAT—Samundra-phala; HINDI—Hijgal, Hyal, Hyar, Ijal, Ingar, Injar. Jujar, Neora, Panniari, Samundar-phal; KANARESE—Hole-kauva, Mavinkubia, Niru-ganigily; KHARWARI—Ingan; KOLAMI—Dundi, Saprung; KONKANI—Nivar; MADRAS—Samuttra-palei; MALAYALAM—Attampu, Attupera, Nir-perzha, Nir-pera, Seriya-samstaravati; MARATHI—Datte-phal, Ingli, Jugli, Nevar, Nivar, Pivar, Samudra-phala, Satha-phala, Tivar, Tuvar, Tvara; MONGHYR—Ijar; MUNDARI—Dundi, Saparung; SANSKRIT—Hijjala, Nichula; SANTAL—Hinjol, Hinjor; TAMIL—Adampa, Adappa-maram, Perungaduppai; TELUGU—Balla, Kadamik, Kadammu, Kadapa, Kanapa, Kanigi, Kurpa; TULU—Nir-daddal; URDU—Samundar-phal; URIYA—Hijal, Hinjal, Hinjara, Hinjolo, Kinjolo, Nijhira.

Botanical characters

A small or medium-sized tree up to 40 ft. high. Leaves attaining 8 by 4 in. but usually smaller, cuneate-elliptic, minutely denticulate-crenate, narrowed into the petiole $\frac{1}{8}$–$\frac{1}{2}$ in. Flowers $\frac{1}{3}$–$\frac{1}{2}$ in. diam., pink, in long drooping racemes often 1 ft. or more long. Calyx-lobes 4, imbricate. Ovary 2-celled. Fruit 1–$1\frac{1}{2}$ by $\frac{1}{2}$–$\frac{3}{4}$ in., quadrangular-oblong, slightly narrowed towards and subtruncate at each end.

Distribution

One of the most plentiful trees in Bengal, especially near the coast beyond the tidal range. Thence it extends to the forests of Rohilkhand and Oudh usually on the banks of streams or in moist ground, and towards Western and Southern India where it is found in Konkan, Southern Mahratta Country, Kanara, Western Ghats, and eastern and western coastal districts of the Madras Presidency along streams and

on swampy land. It is, however, scarce in places far away from the sea.

Uses and properties

The leaves, fruits, roots, and seeds are used in indigenous medicine. Even a few grains of the fruit seldom fail to induce vomiting.

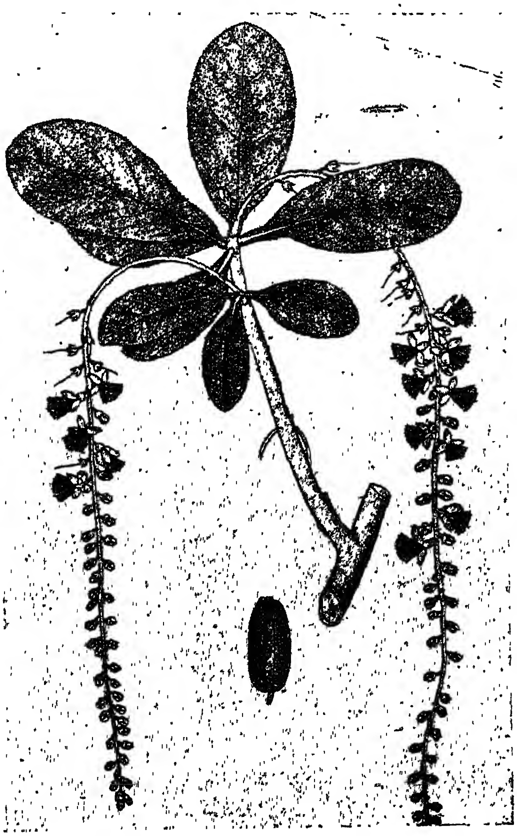

FIG. 91. *Barringtonia acutangula* (Linn.) Gaertn.

The bark is used to stupefy fish in many parts of India. The seeds and roots are also said to be used for the same purpose (*1*).

Constituents

The fruits examined by the authors were found to contain two saponins, which possessed strong haemolytic properties; they were also markedly toxic to fish. In concentration of 1 c.c. of 1 per cent saponin to a litre of water, they paralyzed the respiratory organs and produced asphyxia and death. The leaves did not show the presence of any saponin (*2*).

2. Barringtonia asiatica (Linn.) Kurz

B. speciosa Forst., Fl. Brit. Ind., II, 507.

Vernacular names: ANDAMANS—Dodda; BURMA—Kyaigyee, Kyi; KANARESE—Samudra-phala; TAMIL—Ondalam, Samuttira-palam, Semmulli; TELUGU—Suraponna.

Botanical characters A rather small or moderate-sized tree 30 to 50 ft. high. Leaves often 15 by 7 in., obovate, tapering to base, obtuse, entire, sessile. Flowers $\frac{3}{4}$ in. diam., on short erect racemes. Calyx-lobes 2, valvate. Petals white, 2–2$\frac{1}{4}$ in. Ovary 4-celled; ovules about 6 in each cell; style often exceeding 4 in. Fruit 3 by 3 in., quadrangular or nearly ovoid.

Distribution Native of the Andaman Islands, Singapore, and Ceylon; also occurs in the Southern Deccan Peninsula, but not in a wild state.

Toxicity This plant possesses narcotic properties and stupefies fish without killing them. The seeds are also said to be poisonous to fish.

Constituents The active principle of the bark is stated to be a volatile oil combined with a resin (*3*). The seeds contain 3·27 per cent of a glucosidic saponin, barringtonin, and 1 per cent of a substance designated as barringtogenitin (*4*).

3. Barringtonia racemosa (Linn.) Roxb.

B. racemosa Blume, Fl. Brit. Ind., II, 507.

Vernacular names; BENGAL—Kunda, Samudra-phal; BURMA—Kyaibeng, Kywegyi; HINDI—Ijjul; KANARESE—Kanaginatora, Kempu-ganigilu, Samudra-phala; KONKANI—Nivar; MALAYALAM—Katampu, Kuddapah, Samstaravati, Samudra-cham, Samudra-pu; MARATHI—Nivar, Samudra-phal; SANSKRIT—Nipa; TAMIL—Samuttra-palam; TELUGU—Kadapa, Kanapa, Samudra-pandu.

Botanical characters An evergreen ornamental tree up to 50 ft. high. Leaves 10 by 3 in., cuneate-oblong, lightly crenate-denticulate; petiole $\frac{1}{8}$–$\frac{1}{4}$ in. Racemes 12–18 in., pendulous. Flowers 1$\frac{1}{2}$–2 in. diam., cream-coloured, distant; pedicels $\frac{1}{4}$–$\frac{1}{6}$ in. Calyx-tube in the bud broadly funnel-shaped; segments 2–3, valvate. Stamens pink. Style often 1$\frac{1}{2}$ in. Fruit 1$\frac{3}{4}$ by 1$\frac{1}{2}$ in., ovoid, obscurely quadrangular below when quite ripe; pericarp very thick, fibrous.

Distribution Common along the western coast from the Konkan to Travancore, and from the Sundarbans eastwards, along rivers and backwaters near the sea; often planted for ornamental purposes.

Toxicity The seed is used as a household vermifuge in Madagascar, and is stated to be a fish poison (*5*). The plant possesses toxic and insecticidal properties (*2*).

2. CAREYA Roxb.

(In honour of the Rev. William *Carey* of Serampore, a botanist, who was the publisher of Roxburgh's "Flora Indica".)

Trees or a small undershrub. Leaves alternate, crowded towards the ends of the branches, slightly crenate-serrate, penninerved, not dotted, narrowed at the base. Flowers large, in racemes or interrupted spikes. Calyx-tube campanulate or funnel-shaped, hardly produced above the ovary; lobes 4. Petals 4. Stamens numerous, slightly connate at the base; innermost or outermost filaments or both often without anthers. Ovary inferior, 4–5-celled, crowned by an annular disc; ovules very many. Fruit large, globose, fleshy, crowned with the calyx, indehiscent. Seeds numerous, embedded in pulp. *Botanical characters*

Indo-Malayan. *Distribution*

Careya arborea Roxb.

Fl. Brit. Ind., II, 511.

(Wild Guava)

Vernacular names: Balaghat—Gumar; Banda—Kumbhi, Pilu, Vakamba; Bengal—Kamba, Kumbh, Kumbhi, Kumhi, Vakamba; Burma—Bambwe, Banbwe; Chhindwara—Kumri; Garo—Dambel; Gond—Gummar; Gujerat—Kombi, Kumbi; Hindi—Kamba, Khumbi, Kumbh, Kumbi, Kumbhi, Kumhi, Vakamba; Kanarese—Ala-gavvele, Daddal, Doddala, Gavva-hannu, Gavvele, Goddadayippe, Hennumatti, Kaulu, Kaval, Pilu; Kolami—Asanda, Asunda; Konkani—Kumbio; Kumaon—Khumbhi; Lepcha—Boktok; Madras—Peyttandi; Malayalam—Alam, Pela, Pelu, Pera, Perzha, Pilu, Uka; Marathi—Kuba, Kumbha, Kumbhasala, Kumbia, Vakumbha; Mysore—Gavuldu; Mundari—Asandudaru, Kombir, Kumbir; Nepal—Kumbhi; Punjab—Kumbhi (flowers), Vakhumba; Sanskrit—Kumbhi; Santal—Kumbir; Tamil—Ayma, Karekku, Khumbhi, Pela, Puda-tanri; Telugu—Araya, Buda-darini, Buda-durmi, Budda-burija, Buda-tadadimma, Buda-tanevadi, Duddippa, Dudippi, Gadhava, Govadi, Kumbhi; Tulu—Daddal; Uriya—Kumbhi.

A medium-sized tree attaining 30–60 ft. Leaves 6–15 by 3–7 in., obovate or obovate-oblong, obtuse or shortly acuminate. Spikes about 3-flowered, 3–8 in. long. Flowers $2\frac{1}{2}$–4 in. diam., cream or white, ill-smelling. Petals 1–2 in., elliptic, obtuse. Fruit green, 2–3 in. diam., globose, surmounted by an enlarged mouth having a depressed pit at the vertex within the calyx-teeth and the remains of the style. *Botanical characters*

Frequently found in deciduous forests and shady places in the Sub-Himalayan tract from the Kangra district eastwards, and in Bengal. Central, Western and Southern India up to an altitude of 5,000 ft. *Distribution*

The bark, fruit, and flowers are used in indigenous medicine. The Mundas of Chota Nagpur use the root, bark, and the leaves to kill fish (7). In Mysore, according to a recent report by the Chief Conservator *Uses and properties*

of Forests, the inner bark is rubbed on the shoes to ward off leeches and is stated to be quite effective.

FIG. 92. *Careya arborea* Roxb.

Constituents

The leaves contain about 19 per cent of tannins and the wood also contains tannins (*8*).

3. EUCALYPTUS L'Hérit.

(From the Greek *eu*—well, and *kalyptos*—covered; referring to the fused petals covering the orifice of the calyx-tube in bud and which fall off at anthesis.)

Botanical characters

Trees, often very large, secreting an aromatic gum or resin. Leaves usually opposite when young, in older trees different in shape and usually alternate, hanging obliquely or vertically, more or less falcate, entire, penninerved, studded with oil glands. Flowers usually white, in heads or umbels, rarely solitary, axillary. Calyx-tube adnate at the

base to the ovary, truncate at the apex, sometimes with very small lobes. Petals fused into a calyptra which falls off by the pressure of the growing stamens. Stamens numerous, free. Ovary 3–6-celled, many-ovuled. Fruit a hardened capsule, dehiscing loculicidally at the top. Seeds numerous, small.

Economic aspects

The majority of the species of *Eucalyptus* which are evergreen trees or shrubs are confined to Australia and Tasmania where they form a characteristic feature of the landscape of these countries. Most of these are valued for their timber. Out of about 300 species of the genus about 25 yield the eucalyptus oil of commerce. Chief amongst these are *E. globulus* Labill., *E. dumosa* A. Cunn. *ex* Schau., *E. polybractea* R. T. Baker, and *E. dives* Schau. The oil obtained from *E. dives* contains a large proportion of piperitone which is used in the manufacture of thymol. Another foreign species, *E. maculata* Hook., yields "lemon-scented" eucalyptus oil and contains about 20 per cent of cineole. Eucalyptus kino, which is largely used as an astringent for sore throat, is the dried juice obtained from *E. amygdalina* Labill., *E. marginata* Sm., and *E. rostrata* Schlecht. The constituents of the gum are tannic acid, catechin, pyrocatechin, resin, and certain crystallizable bodies.

Eucalyptus globulus Labill.

(Blue Gum).

Vernacular names: TAMIL—Karupura-maram, Kurpura-maram.

Botanical characters

A gigantic tree with smooth bark peeling off in long strips which often remain hanging on the stems and branches. Leaves 8–10 in. long, falcate, curved, rather thick, those of seedlings sessile, opposite, horizontal, broadly ovate, very glaucous, with a bluish hue. Flowers large, axillary, 1–3 together, nearly sessile. Calyptra thick, warty, low, abruptly pointed. Fruit $\frac{7}{10}$–1 in. diam., warty, angular, valves exserted.

Distribution

Gregarious in Victoria and in the south of Tasmania; introduction into India has met with complete success in the Nilgiris where the plantations started in 1863 are well established. It does not thrive in the plains nor on the outer Himalayan ranges.

Uses and properties

The fresh leaves and young shoots contain 1·3 to 3·2 per cent of a volatile oil, the oil of eucalyptus (*9*), which is rich in cineole (a terpene oxide), the percentage being sometimes as high as 83·7 (*10*). Eucalyptol (commercial cineole) is obtained chiefly from oil of eucalyptus, but also occurs in other oils, such as cajuput oil. The essential oil also contains pinene, eudesmol, pinocarveol, sesquiterpenes, and aldehydes (*11*).

Eucalyptol is the most important ingredient from the medicinal point of view; it is a mild local irritant and antiseptic, and is used especially

in bronchitis. Internally it is given in doses of 5 to 10 drops in sugar. Idiosyncrasy towards small doses is manifested by skin eruptions.

FIG. 93. *Eucalyptus globulus* Labill.

Large doses of eucalyptol or the related myrtol produce fatal collapse from intestinal irritation. Death occurred in about one third of the human subjects who had taken 10 to 30 c.c. (*12*). The effects of poisoning with eucalyptus oil are gastro-intestinal irritation and cerebral paresis with vomiting and diarrhoea (*13*). These effects are recorded from the use of the oil in doses of 1 to 6 drachms. Intense drowsiness followed by sleep has been produced from a dose of 3 drachms (*14*). Marked cyanosis has been produced by a dose of about half an ounce (*15*).

Eucalyptus oil is also largely used as a mosquito and vermin repellent, and is an important constituent of several insecticides.

Phellandrene, present in the Australian oil to a fairly large extent, is very irritant to the bronchial mucosa, especially if inhaled, and has been considered to be powerfully depressant to the heart. The British Pharmacopoeia tests expressly exclude oils containing large quantities of this principle. The butyric and valeric aldehydes are also obnoxious constituents in the Australian oil. Both these constituents are absent from the Indian oil, and this fact deserves the consideration of physicians since it is less likely to produce coughing and other unpleasant side-effects (*16*).

4. MELALEUCA Linn.

(From the Greek *melas*—black, and *leukos*—white; in allusion to the black trunk and white branches in one of the species.)

Botanical characters

Trees or shrubs. Leaves alternate, lanceolate or linear, gland-dotted. Flowers in heads or spikes, each sessile in the axil of a deciduous bract. Calyx-tube subglobose; lobes 5. Petals 5, spreading, deciduous. Stamens numerous, more or less united at their bases into 5 bundles opposite the petals and exceeding them. Ovary inferior or ½-superior. Capsule dehiscing loculicidally from above by 3 valves.

Distribution

This is purely an Australian genus except one species which extends into the tropical regions of Asia.

Melaleuca leucadendron Linn.

Fl. Brit. Ind., II, 465.

(Bottle Brush, Cajuput, Paperbark, White Tree)

Vernacular names: BENGAL—Kajuputte; BOMBAY—Kayakuti, Kayaputi; HINDI—Kayaputi; MARATHI—Kajuputa; PATNA—Ilachie; TAMIL—Kaiyapudai; Kayapute, Kijapute.

Botanical characters

An evergreen tree often of large size with pendulous branches, or stunted with stiff erect branches. Leaves narrow and 6–8 in. or broader and 2–4 in., elliptic or lanceolate, acuminate, acute or obtuse, straight, oblique or falcate, 3–7-nerved with anastomosing nerves. Spikes 2–6 in. long, interrupted, solitary or 2 or 3 together, terminal at first and then surmounted by leafy branches. Flowers whitish. Capsule $\frac{1}{6}$ in. diam., subglobose.

Distribution

Found in Tenasserim, Mergui, Malacca, Malay Islands, and Australia. Var. *leucadendron* Duthie, with glabrous spikes, is cultivated in India. It is a much larger tree than the var. *minor* Duthie, with villous spikes

The latter, according to Watt (*3*), is apparently the source of the commercial cajuput oil

FIG. 94. *Melaleuca leucadendron* Linn.

Uses and properties

The cajuput oil distilled from the fresh leaves and twigs of this plant is a transparent fluid of fine green colour, and has a lively, penetrating odour analogous to that of camphor and cardamom, and a warm pungent taste. In Western medicine it is employed as a counterirritant. The oil is also a stimulant, producing a sense of heat with increased fulness and frequency of the pulse, exciting in some instances profuse perspiration. It contains mainly cineole, l-pinene, terpineol, etc. (*11*). The oil is an excellent mosquito repellent, and has the advantage over oil of citronella in that it volatilizes more slowly.

The oil and its water-soluble emulsion obtained from a foreign species, *M. alternifolia* Cheel, have been found to possess antiseptic properties in surgical and dental work (*17*).

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Family XXXV.—LYTHRACEAE

(Henna and Pomegranate Family)

Botanical characters

Trees, shrubs or herbs, often with 4-angled branches. Leaves entire, usually opposite, occasionally alternate or whorled, exstipulate. Flowers hermaphrodite, usually regular, often in cymes or panicles. Calyx-tube usually free, peristent; lobes 3–6, often with accessory teeth. Petals as many as the primary calyx-teeth, inserted near the top of the calyx-tube, rarely 0. Stamens definite or indefinite, episepalous. Ovary superior (rarely inferior, as in *Punica*), 2–6-celled; style long; stigma capitate, rarely 2-lobed; ovules numerous, placentas axile, rarely parietal. Fruit capsular or baccate, membranous or coriaceous, girt round the base by the calyx or included in or surmounted by it, 2–6-celled, sometimes 1-celled by absorption of the septa, dehiscent or not. Seeds many, sometimes winged, exalbuminous.

Distribution

Tropical regions of the whole world, especially of America; a few species grow in the temperate zones.

Economic aspects

This family contains a number of useful plants. Henna (*Lawsonia inermis* Linn., syn. *L. alba* Lam.) is an ornamental and fragrant shrub, the leaves of which are largely used in India as a cosmetic for application to the hands, to which they impart a reddish colour. *Lagerstroemia speciosa* (Linn.) Pers. (*L. flos-reginae* Retz.), a handsome ornamental tree, is much cultivated on the roadsides all over India; the seeds of this plant are said to have narcotic properties. Indian lilac (*Lagerstroemia indica* Linn.) is also cultivated in gardens. The fresh juice of blistering ammannia (*Ammannia baccifera* Linn.) raises blisters. The species of *Sonneratia* are mangrove plants. *Cuphea viscosa* Rose from Mexico contains a substance similar in action to digitalis. *Punica granatum* Linn. yields the well-known fruit pomegranate. The root-bark of this plant is employed in medicine as an anthelmintic, and contains the alkaloids pelletierine, ψ-pelletierine, and methyl-*iso*pelletierine.

Some members of the family are astringent, others are acrid, emetic, cathartic, and diuretic. Some of the plants contain tannins and essential oils.

KEY TO THE GENERA

A. Herbs growing in moist places .. .. .. 1. *Ammannia.*

B. Trees or shrubs.

- *a.* Ovary superior. Capsule 3–6-valved. Seeds winged 2. *Lagerstroemia.*
- *b.* Ovary inferior. Berry globose. Seeds angular; testa coriaceous with a watery outer coat .. 3. *Punica.*

1. AMMANNIA (Houst.) Linn.

(In honour of Johann *Ammann*, a Swiss botanist of the eighteenth century.)

Botanical characters

Small annual glabrous herbs growing in damp places. Leaves opposite or upper alternate, rarely whorled. Flowers small, axillary, solitary and subsessile, or in small trichotomous cymes; bracteoles usually 2. Calyx campanulate or tubular-campanulate, 3–5-toothed, often with small intermediate teeth or folds. Petals 3–5 or 0, small, inserted between the calyx-teeth. Stamens 3–8, rarely 2. Ovary enclosed in the calyx-tube, 1–5-celled. Capsule thin-walled, globose or long-ellipsoid, enclosed in the calyx, 2–3-valved, or irregularly dehiscing or circumsciss. Seeds small, smooth.

Distribution

In the tropics and warm temperate regions of the whole world.

KEY TO THE SPECIES

a. Leaves tapering at base. Flowers clustered in the leaf-axils. Stamens 4 .. .. 1. *A. baccifera*.

b. Leaves subauriculate at base. Flowers in compound, distinctly peduncled cymes. Stamens 6 or 8 .. 2. *A. senegalensis*.

1. Ammannia baccifera Linn.

Fl. Brit. Ind., II, 569.

(Blistering Ammannia)

Vernacular names: BENGAL—Ban-marich, Dad-mari; DECCAN—Agin-buti, Agiya, Ban-marich, Bhar-jambol, Guren; GUJERATI—Jala-agiyo; HINDI—Dad-mari, Jangli-mehndi, Kuranda; MALAYALAM—Kallurvanchi; MARATHI—Bhara-jambhula; MUNDARI—Gara-tulsi, Gara-turusi; PUNJAB—Dadar-buti; SANSKRIT—Kshetrabhusha, Kshetravashini, Kurandika, Kuranti, Sukaranda, Vikata; TAMIL—Kallu-rivi, Nirumel-neruppu; TELUGU—Agnivenda-paku; URDU—Agya.

Botanical characters

An erect branched herb 6–24 in. high with lower leaves and branches usually opposite. Cauline leaves 1–2½ in. long, opposite or alternate, oblong or narrow-elliptic, narrowed at both ends. Flowers minute, green, in dense axillary clusters or in very short axillary cymes. Calyx-teeth 4, accessory teeth small. Petals 0 or inconspicuous. Stamens 4. Capsule depressed, globose, breaking up irregularly above the middle.

Distribution

Generally met with in wet places throughout India.

Uses and properties

This plant is exceedingly acrid and has a strong muriatic but not disagreeable smell. The fresh bruised leaves are said to raise blisters, the pain caused during the process being excessive. In indigenous medicine, the juice of the plant is given internally in the treatment of

enlargement of the spleen, but it causes great pain and the result is not certain (*1*).

FIG. 95. *Ammannia baccifera* Linn.

2. Ammannia senegalensis Lam.

Fl. Brit. Ind., II, 570.

Vernacular names : PUNJAB—Dad-mari, Faugli-mehndi.

Botanical characters

An erect herb 6–24 in. high, with sharply quadrangular branches. Cauline leaves 1–2 in. long, opposite, elongate-oblong, sessile, sub-auriculate at base. Flowers in axillary shortly peduncled compound cymes. Calyx with 4 or 8 green lines becoming indistinct in fruit, obs-

curely 4-toothed. Petals 4, pink, caducous. Stamens 6 or 8. Capsule $\frac{1}{12}$ in. diam., globose, opening irregularly.

Distribution Met with in the plains of Bengal and Northern India, rising up to an altitude of 5,000 ft. or more in the North-Western Himalayas.

Toxicity This plant is used in indigenous medicine for raising blisters.

2. LAGERSTROEMIA Linn.

(After Magnus von *Lagerström*, a Swedish merchant.)

Botanical characters Trees or shrubs. Leaves opposite, distichous, or the uppermost alternate, entire. Flowers usually showy, in axillary and terminal usually trichotomous panicles; peduncles 2-bracteate at apex; pedicels 2-bracteolate. Calyx-tube campanulate, coriaceous; lobes 6, sometimes 7–9. Petals 6, sometimes 7–9 (or 0), inserted at the summit of the calyx-tube, clawed, wrinkled, margin crisped, erose or fimbriate. Stamens numerous. Ovary 3–6-celled; style long, bent; stigma capitate; ovules many. Capsule more or less adnate to the calyx, ellipsoid, coriaceous, smooth, 3–6-celled, loculicidally 3–6-valved. Seeds many, rarely few, winged at the apex, flat.

Distribution South-East Asia, extending to Australia, Burma being the chief centre.

KEY TO THE SPECIES

a. A shrub. Calyx-tube without ribs. Petals variously coloured 1. *L. indica.*
b. A tree. Calyx-tube strongly ribbed. Petals mauve .. 2. *L. speciosa.*

1. Lagerstroemia indica Linn.

Fl. Brit. Ind., II, 575.

(Crape Myrtle, Crepe Myrtle, China Privet, Indian Lilac)

Vernacular names: BENGAL—Phurush, Telinga-china; BOMBAY—Dhayti; HINDI—Farash, Phurush, Saoni, Telinga-china; TAMIL—Pavala-kurinji, Sinappu, Telanga-china, Tindiyam; TELUGU—China-goranta.

Botanical characters A very ornamental shrub or a small tree. Leaves 2 in., glabrous, elliptic or oblong, sessile, never acuminate. Panicles numerous, bearing white, lilac or rose-coloured flowers 1–1½ in. diam. Calyx-tube not ribbed, glabrous. Petals ½–¾ in., long-clawed, variously coloured. Capsule ⅓ in. diam., subglobose; calyx-teeth erect on the fruit.

Distribution Originally from China, this plant is now common in Indian gardens.

Toxicity In Indo-China, the bark, leaves, and flowers are considered to be hydragogue and drastic purgative.

2. Lagerstroemia speciosa (Linn.) Pers.

L. flos-reginae Retz., Fl. Brit. Ind., II, 577.

Vernacular names: ASSAM—Ajhar, Jarul; BENGAL—Jarul; BURMA—Eikmwe, Pyengma, Pyinma, Kone-pyinma; GARO—Bolashari; HINDI—Arjuna, Jarul; KANARESE—Challa, Holeda-challa, Holeda-sal, Holematti, Maruva, Maruva-challa, Nir-bendeka; KOLAMI—Gara-saikre; KONKANI—Tamonn, Bondara, Mota-bondara; MAGAHI—Kamaung; MALAYALAM—Adamboe, Atampu, Chemaruta, Katalpu, Mani-marutu, Nir-marutu, Nir-ventekku, Puval-ventekku; MARATHI—Bondara, Mota-bondara, Taman, Tamana; MUNDARI—Gara-sekere, Kuiri; SANSKRIT—Arjuna; SANTAL—Sekra; TAMIL—Kadali, Kadali-mugai, Kadali-puva, Pu-marudu, Pu-maruthu; TELUGU—Chonnangi, Varagogu, TULU—Challa; URIYA—Ary, Jarulo.

Botanical characters

A tree reaching 50 to 60 ft. high, very handsome from its large panicles bearing large mauve flowers 2-3 in. across. Leaves 4–8 in.

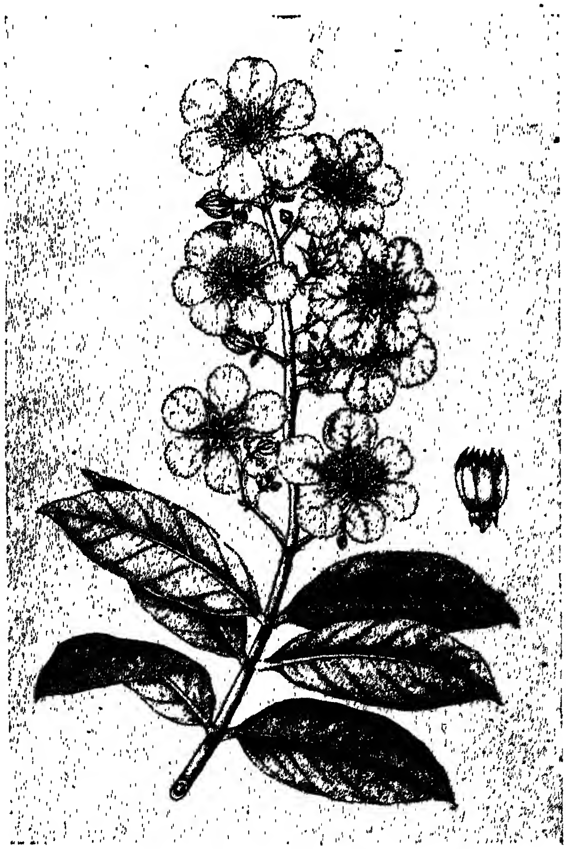

FIG. 96. *Lagerstroemia speciosa* (Linn.) Pers.

long, broad-elliptic obtuse to oblong-lanceolate, glabrous; petiole usually ¼ in. Calyx covered with hard white (sometimes ferruginous)

tomentum ; ribs 12–14, flat or round, not acute on the back. Margin of petals erose-undulate. Ovary glabrous at the top. Fruit 1¼ by 1 in., ellipsoid or subglobose, woody, septifragally 5–6-valved.

Distribution

Found in Eastern Bengal, Assam, Chota Nagpur, and in the deciduous and semi-evergreen forests of the Eastern and Western Ghats, chiefly along the banks of rivers and ravines up to an altitude of 3,000 ft. Extensively cultivated for ornamental and shade purposes in other places.

Toxicity

The bark and leaves are said to be purgative, and the seeds are believed to have narcotic properties (*1*).

3. PUNICA (Tourn.) Linn.

(From *Malum punicum*, the name used by Pliny; said to be from the Latin *punicus*, belonging to Carthage, the city of Poeni, near which it is said to have been first found ; or from *puniceus*—scarlet, in reference to the colour of the flowers.)

Botanical characters

A large shrub, often armed. Leaves opposite, subopposite or clustered, oblong or obovate, obtuse, entire. Flowers shortly pedicelled, axillary, solitary or somewhat clustered, large, orange-red. Calyx-tube funnel-shaped, coriaceous, adnate to the ovary below ; lobes 5–7. Petals 5–7, wrinkled, inserted between the calyx-lobes. Stamens numerous. Ovary inferior, with many cells in two whorls ; style long, bent ; stigma capitate. Fruit a spherical berry crowned by the calyx-limb. Seeds numerous, with a watery outer coat and horny inner coat.

Distribution

North-Western India.

Punica granatum Linn.

Fl. Brit. Ind., II, 581.

(Pomegranate)

Vernacular names : ARABIC—Rana, Rumman, Shajratur-rumman ; ASSAM—Dalim ; BENGAL—Dalim ; BURMA—Sale-bin, Tali-bin, Thale ; GUJERAT—Dadam ; HINDI—Anar, Darim, Dhalim, Dharimb ; JAUNSAR—Danoi, JHALAWAR—Anar, Sor ; KANARESE—Dadima, Dadimbe, Dalimbe, Huli-dalimbe, Husi-dalimbe ; KONKANI—Dalimb, Dallimbini ; KUMAON—Darim ; MALAYALAM—Dadiman, Matalam, Pumatalam, Rakta-bijam, Talimatalam, Uruyampalam ; MARATHI—Dalimba ; MUNDARI—Anardaru ; PERSIAN—Anar ; PUNJAB—Anar, Daan, Danu, Daran, Dariun, Daru, Daruna, Daruni, Dharu ; PUSHTU—Anar, Anor, Ghar-nangoi, Nargosh ; QUETTA—Anar-bedana ; SANSKRIT—Darimba ; SIBI—Anar, Dahrun ; SIND—Anar, Dhalim, Dharimb ; TAMIL—Kalumal, Madalai, Madulam, Madulungam, Magilan, Pumadalai, Pulimadalai, Tadimadalai, Tadimam, Tusagam ; TELUGU—Dadimamu, Dadimba, Dalimma, Danimma, Karakamu, Pulla-danimma, Puvvu-danimma, Tiyya-danimma ; TULU—Dalimbe ; UNITED PROVINCES—Anar, Darim ; URDU—Anar ; URIYA—Dalimbo, Dalimo.

Botanical characters

A large deciduous shrub or a small tree, often armed. Leaves 1–2½ in. long, minutely pellucid-punctate, oblong or obovate, base narrowed into a very short petiole. Flowers 1½–2 in. long and as much across,

Fruit $1\frac{1}{2}$–3 in. diam.; the interior septate with membraneous walls and containing numerous seeds angular from mutual pressure.

Distribution

Wild in the Salt Range and in the Himalayas at altitudes from 3,000 to 6,000 ft.; cultivated in many parts of India.

Uses

Pomegranate has been highly prized from remote antiquity both as a fruit and for its medicinal properties. The flowers and rind of the fruit are employed in a variety of ways on account of their astringency. The root-bark, especially when fresh, is considered to be the most astringent part of the plant, and is also believed to be a specific remedy in the treatment of tapeworms. It is unpleasant to take, and, on account of the large quantities of tannic acid contained in it, is liable to produce nausea and vomiting.

Constituents

The important alkaloids found in the bark are pelletierine, ψ-pelletierine, and methyl-*iso*pelletierine (*2*). The content of the total alkaloids in the fresh stem- and root-barks has been found to vary from 0·5 to 0·7 per cent, of which pelletierine amounts to 40 to 50 per cent (*3*).

Pelletierine is highly toxic to tapeworms, and this is the reason why the bark is employed against infestation with this helminth. Crude mixtures of tannates and sulphates of this alkaloid have been employed in medicine as anthelmintics under the names pelletierine tannate and pelletierine sulphate (*2*).

The following account of the pharmacological action and toxic effects of pelletierine is taken from Chopra and Chandler (*4*).

Pharmacological action and toxic effects

"The action of pelletierine resembles that of arecoline. In the frog it produces reflex irritability followed by convulsions. In the higher animals it stimulates the central nervous system at first, and later depresses it; the special senses are affected and the vision may become dim and blurred. The drug also has a marked action on the skeletal muscles which closely resembles that of veratrine; the motor nerve endings in the muscles are finally paralyzed in the same way as with curare; death occurs from failure of respiration.

"Large doses of the decoction or the pure alkaloids produce headache, dizziness, dimness of vision, nausea, vomiting, diarrhoea and extreme muscular weakness followed by paralysis. There is increase of reflexes, followed by a sense of weakness in the limbs, twitchings, and cramp in the muscles of the leg. Cerebral symptoms such as vertigo, drowsiness and coma may supervene. Serious disturbances of vision as with filix-mas, dilatation of the pupil, amaurosis and retinal congestion may rarely occur. Pelletierine sulphate is readily absorbed by the stomach and in large doses produces constitutional symptoms.

Pelletierine tannate passes through the stomach and the toxic symptoms are not produced.

Treatment

" Treatment is largely symptomatic. The bowels should be rapidly emptied with salines and artificial respiration given if the respiratory muscles are affected.

Pelletierine as anthelmintic

" Pelletierine has the reputation of being a powerful taeniacide in dogs and is usually given after fasting in doses of 4 grains suspended in water ; two hours later a dose of castor oil is given.

" *In vitro* experiments show pelletierine to be much less effective against nematodes than tapeworms, probably because it does not penetrate the cuticle, and clinical experience bears out the conclusion that it is of little or no use against any kind of nematodes. We have no data on its effectiveness against flukes. "

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Family XXXVI.—SAMYDACEAE

(Casearia Family)

Botanical characters

Trees or shrubs. Leaves usually alternate and distichous, petiolate, simple, often with pellucid glands; stipules small, deciduous. Flowers regular, small, axillary, fasciculate, or in long simple or panicled racemes. Calyx coriaceous, persistent; tube short or long, rarely adnate to the ovary; lobes 3–7. Petals as many as the calyx-lobes or 0, perigynous. Stamens definite or indefinite, often with staminodes between or united in a tube with them. Ovary superior or half-superior, 1-celled; style 1, capitate or 3-fid at the apex, or styles 2–5; ovules usually many, on 2–5 (usually 3) parietal placentas. Fruit loculicidally 2–5- (usually 3-) valved. Seeds few or many, albuminous, usually arilled.

Distribution

In the tropics, rarely also in the subtropical regions.

Economic and toxic aspects

Species of *Casearia* are used in indigenous medicine as cathartics and to promote the action of the liver. A number of plants belonging to this family are regarded as fish poisons, though their chemical composition has not been worked out.

CASEARIA Jacq.

(In honour of Johann *Casearius*, a Dutch missionary in Cochin-China and a botanical author of the seventeenth century, who assisted Rheede in the "Hortus Malabaricus".)

Botanical characters

Shrubs or small trees. Leaves often minutely punctate beneath, entire or slightly serrate. Flowers small, greenish-yellow, in axillary fascicles (Indian species); pedicels jointed above their base, surrounded by many small bracteoles. Calyx inferior, deeply 4–5-lobed; lobes obtuse, persistent. Petals 0. Stamens usually twice the number of calyx-lobes, united in a tube with staminodes alternating with the free portion of the filaments; staminal tube sometimes very short so that the filaments are nearly or quite free. Ovary free; style simple; stigma capitate or 3-fid. Capsule succulent, globose or ellipsoid (when dry sometimes 3-angular or 6-ribbed), 3- rarely 2-valved. Seeds many, angular or obovoid, with an enveloping fleshy coloured (usually orange or red) aril.

Distribution

Most plentiful in America.

Toxic aspects

Several members of the genus are used as fish poisons.

KEY TO THE SPECIES

a. Leaves glabrous; stipules about ½ in. long .. .. 1. *C. graveolens.*
b. Leaves generally tomentose beneath, sometimes slightly hairy; stipules minute .. .. .. 2. *C. tomentosa.*

1. Casearia graveolens Dalz.

Fl. Brit. Ind., II, 592.

Vernacular names: ALMORA—Pimperi, Pipri; DEHRA DUN—Nar, Nara, Narha; GARHWAL—Narva, Phempsi, Pimperi, Pipri; GOND—Girchi, Tundri; HALDWANI—Narra; HINDI—Aloal, Chilla, Chilli, Kathera, Naro, Pimpri; KANARESE—Hanise; KOLAMI—Reri; KURKU—Rewat; MALAYALAM—Anavananni, Cherukannan; MARATHI—Bokhada, Bokhara, Moda; PUNJAB—Chilla; SANTAL—Neuri, Nuri; URIYA—Giridi, Jamurdi, Kakoli, Khonji, Kirtti, Kokra.

Botanical characters

A shrub or a small tree. Leaves up to 6–7 in. long and 4 in. broad, elliptic, obtuse or shortly pointed, more or less crenate-serrate, glabrous, prominently reticulate; stipules about ½ in. long, lanceolate-subulate, deciduous. Flowers green, foetid, $\frac{1}{5}$ in. diam.; pedicel glabrous above the articulation. Calyx always pubescent at the base, above sometimes glabrous. Stigma discoid. Capsule yellow, about ¾ in. long, ellipsoid.

Distribution

Found in the Sub-Himalayan tract from the Chenab eastwards to Sikkim, ascending to an altitude of 5,000 ft.; also in the Upper Gangetic Plain, Bihar, Konkan, the Deccan, and the Northern Circars in Ganjam.

Toxicity

The fruit is used to poison fish, and an infusion of the same is also said to have a poisonous effect on human beings (*1*).

2. Casearia tomentosa Roxb.

Fl. Brit. Ind., II, 593.

Vernacular names: BENGAL—Maun; BHIL—Tordul; BOMBAY—Bairi, Chari, Chillara; GOND—Thundri, Tondri, Tundri; GUJERATI—Gholoum, Sunjhal; HINDI—Baira, Bhari, Bhori, Chilara, Chilla, Churchu; KANARESE—Bhil, Bilioobina, Biliyubina, Hanise; KOLAMI—Rore; KUMAON—Chilla; MALAYALAM—Anakkarana, Anavananni, Vapunnakannan; MANBHUM—Maun; MARATHI—Karei, Lainja, Massei, Modgi, Modi; MUNDARI—Kurkidaru, Kurkudaru; PUNJAB—Chilla; SANTAL—Chorcho; TAMIL—Kadichai, Kaludu-kutti, Kottal, Kutti; TELUGU—Chilaka-duddi, Gamgudu, Girugudu, Kalamisvari, Mon, Pisiki, Vasanga, Vasa; URIYA—Girari, Giridi, Kakoli, Khonji, Kirtti, Kokra.

Botanical characters

A shrub or a small tree in open lands, a much larger tree in forests; branchlets tomentose or pubescent, rarely glabrous; stipules minute, deciduous. Leaves 3–7 in. by 1½–3 in., elliptic-oblong or lanceolate, acute, more or less obscurely toothed or entire, pubescent or tomentose beneath. Flowers $\frac{1}{5}$ in. diam., greenish-yellow; pedicels and calyx

hairy. Stigma subglobose. Capsule yellow, $\frac{1}{2}$–$\frac{3}{4}$ in. long, broad-ellipsoid.

Distribution

Common throughout India especially in open lands, ascending to an altitude of 3,000 ft. in the Himalayas.

Uses and properties

The leaves, bark, and pulp of the fruit are used medicinally. According to Brandis (*2*), the fruit yields a milky acrid juice which is employed to poison fish. Sometimes the crushed fruit is used for the same purpose. The leaves are not liked by cattle or even goats.

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Family XXXVII.—PASSIFLORACEAE*

(Passion-flower Family)

Botanical characters

Herbs or shrubs, usually climbing by means of tendrils or rarely twining. Leaves alternate, simple or lobed, frequently with glands on the undersurface or petiole; stipules 2 or 0; tendrils axillary or 0. Flowers hermaphrodite or unisexual, axillary, solitary, racemose or cymose-paniculate, often showy. Calyx-tube persistent; lobes 5. Petals 0, or 5 attached to the calyx-tube, free or connate, often marcescent. A 1–many-seriate "corona" of filamentous or other formed scales springs from the calyx-tube, rarely 0. Stamens 5, on a gonophore or free at the base. Ovary superior, on a gynophore or subsessile, 1-celled with 3 parietal placentas and numerous ovules; style 1 or 3; stigmas reniform, capitate or flattened. Fruit a berry or capsule. Seeds many, often pitted, with a fleshy aril; albumen fleshy.

Distribution

In tropical and warm temperate regions; most numerous in South America.

Economic and toxic aspects

The square-stalked passion flower or common granadilla (*Passiflora quadrangularis* Linn.) is cultivated in the hotter parts of India for its flower and sweet acid fruit which are much esteemed. It is accredited with narcotic properties when eaten in excess. Fruits of *P. edulis* Sims (passion fruit), which are of the size of a hen's egg, are edible. The plant is sometimes cultivated in the hills and has 3-lobed, toothed leaves. In case of *P. foetida* Linn., the fruit is emetic. In indigenous medicine, a decoction made from it is used in the treatment of asthma and biliousness, and the leaves are applied to the head as a remedy against giddiness and headache. The plant is cultivated in gardens but is sometimes found wild near towns. It is at once recognized by the moss-like pectinate involucre of the flowers. *Adenia palmata* Engl. (*Modecca palmata* Lam.) is accredited with poisonous properties. Hydrocyanic acid has been reported from *A. wightiana* Engl. (*Modecca wightiana* Wall.) to the extent of 0·061 per cent (*1*). The fruits of *A. digitata* Engl. are used for homicidal purposes in South Africa.

Some of the members exhibit narcotic, anthelmintic, diuretic, and antiperiodic properties.

Most of the plants of the genus *Passiflora* contain hydrocyanic acid (*1*).

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* *Carica papaya* Linn., which is included in this family in the Fl. Brit. Ind., is dealt with under Caricaceae in this work.

ADENIA Forsk. (MODECCA Lam.)

(From the Greek *aden*—a gland; referring to the glands which are usually present on the leaves and tops of the petioles of species of this genus.)

Botanical characters

Twining herbs or undershrubs, tendril-bearing. Leaves entire or palmately lobed or pinnatifid, usually with 2 or more glands on the undersurface and the top of petiole; stipules 0 or inconspicuous. Flowers monoecious, usually small, in axillary cymes, the peduncles often produced into tendrils. Calyx-tube campanulate or tubular; lobes 4–5. Petals 4–5, 1-nerved. Male flowers: Stamens 4–5, at the bottom of the calyx-tube. Ovary rudimentary or 0. Female flowers: Staminodes 4–5. Ovary stalked or subsessile; style 0 or 3-fid; stigmas 3. Fruit a loculicidal 3-valved capsule, many-seeded.

Distribution

In tropics of the Old World.

Toxic aspects

Adenia digitata Engl., a foreign species, has been found to contain 0·04 per cent of hydrocyanic acid in the fresh root, and a toxalbumin, modeccin, in the fresh and air-dried root. Modeccin has the same degree of toxicity as ricin, but without any haemagglutinative property. The symptoms of poisoning in animals are mainly those of hydrocyanic acid, and, if only a sublethal dose has been taken, the affected animals quickly recover. A few days later, however, the effects of the toxalbumin become evident and death may occur within a day or two (2).

KEY TO THE SPECIES

a. Petals springing from the base of the calyx-tube ..	1. *A. palmata*.
b. Petals springing from the throat of the calyx-tube ..	2. *A. wightiana*.

1. Adenia palmata Engl.

Modecca palmata Lam., Fl. Brit. Ind., II, 603.

Vernacular names: KONKANI—Undal; MALAYALAM—Mutakku; TELUGU—Modikka.

Botanical characters

A large perennial herb becoming woody at the base; stem thickened at the nodes; root large, tuberous, fusiform. Leaves 4–5 by 6–7 in., broader than long, membranous, cordate, usually very deeply palmately 5-lobed (rarely 3-lobed or undivided), with 2 glands at the apex of the petiole and 1 at the base of each sinus in the divided leaves, glabrous. Flowers rather large. Petals inserted at the base of the calyx-tube, linear-oblong, ciliate. Corona a ring of threads from the calyx-tube just above the dilated portion. Stamens distant; anthers linear-oblong; filaments connate at the base. Staminodes in female flowers 5, strap-shaped, connate at the base into a membranous cup. Style nearly as long as the ovary, dividing into 3 branches. Fruit reaching

2 in. diam., shortly stalked, globose, apiculate, smooth, orange-coloured, splitting into 3 fleshy valves.

Found in Konkan, North Kanara, the hills of the Carnatic, Western Ghats, and West Coast, in moist hilly areas at low altitudes. *Distribution*

FIG. 97. *Adenia palmata* Engl.

The root is said to be poisonous (*3*). There is a case on record of a girl in Madras who, as a result of eating some fruits, suffered from severe irritant symptoms and died a week later (*4*). *Toxicity*

2. Adenia wightiana Engl.

Modecca wightiana Wall., Fl. Brit. Ind., II, 601.

A tuberous-rooted slender climber. Leaves 2–3 by 2 in., from ovate, entire, rounded or slightly cordate at base to hastate or palmately 3-lobed; petiole 2-glandular at the top, much twisted. Flowers *Botanical characters*

very small. Petals attached to the throat of the calyx-tube, small, obovate. Corona a fringe of short hairs at the base of the petals. Anthers short; filaments combined in a tube. Capsule 1 in. long.

Distribution

Found at low levels in the hill tracts of the Deccan and Carnatic from North Arcot southwards.

Constituents

Hydrocyanic acid has been reported from this plant to the extent of 0·061 per cent (*1*).

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Family XXXVIII.—CARICACEAE

(Papaw Family)

Botanical characters

Small trees, often with an unbranched crown of long-petioled, alternate, palmilobed leaves and with milky juice. Flowers dioecious, sometimes monoecious, the females shortly cymose, solitary or fascicled, axillary, the males in axillary panicles, 5-merous. Calyx short. Corolla of male gamopetalous, of female much larger, polypetalous. Stamens in the male 10, in 2 whorls in the corolla-tube. Female with staminodes. Ovary 1- or 5-celled with short style and 3-5 palmately branched lobes; ovules numerous, parietal. Hermaphrodite flowers occasionally occur in three forms; either the stamens are only 5 hypogynous in an otherwise nearly normal female flower, or the stamens are 10 perigynous inserted high up in a tube adnate to the corolla, or the stamens are 10 epigynous closely adnate to the ovary with their bases connected by a ridge. Fruit a large 1-celled or 5-celled berry. Seeds many, with an outer sappy and an inner hard testa, albuminous.

Distribution

In tropical regions of America and Africa.

Constituents

This family includes the genus *Carica* whose milky juice is rich in the proteolytic enzyme papain. Some plants contain the alkaloid carpaine and the glucoside carposide.

CARICA Linn.

(Named from an erroneous idea that it was a native of *Caria*.)

Carica papaya Linn.*

Fl. Brit. Ind., II, 599, without description.

(Melon Tree, Papaw, Papaya, Papeta, Paupau, Pawpaw, Tree Melon)

Vernacular names: ARABIC—Aanabahe-hindi, Ambe-hindi; BENGAL—Papeya, Pappaiya, Pepe, Pepiya; BURMA—Pimbosi, Simbosi, Thimbaw, Thimbawthi, Timbosi; CUTCH—Papaya; DECCAN—Popai; GUJERAT—Chibda, Eranda-kakdi, Jhad-chibhadi, Kath, Papai, Papayi, Papia; HINDI—Anda-kharbuja, Papaya, Papita, Papiya-amba, Pepiya, Popaiya; KANARESE—Goppe, Pangi, Pappayi, Parangi; MALAYALAM—Kappalam, Karmmosu, Pappayam; MARATHI—Papaya; MUNDARI—Ambritdaru, Amritdaru, Dinda-pabita, Jomejaradaru, Pabita-daru; NEPAL—Mewa; PERSIAN—Aanabahe-hindi, Amba-hindi; PUNJAB—Arand-kharbuja, Kharbuja, Papita; SANSKRIT—Chirbhita, Eranda-chirbhita, Nalikadala; SIND—Chibhado, Katha, Paputa; TAMIL—Pappali, Pappayi, Parangiya-manakku; TELUGU—Boppayi, Madananaba, Madhur-nakamu; URDU—Erand-kharbuzah; URIYA—Ormytobhonda, Popoya.

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* It is included in Passifloraceae in the Fl. Brit. Ind.

Botanical characters

A well-known, almost branchless, soft-wooded, short-lived, small tree with numerous leaf-scars on the stem. Leaves very large, palmately lobed, the lobes again variously lobed. Flowers pale-yellow, fragrant, generally dioecious, but occasionally a few bisexual flowers on the male plant. Male flowers in long drooping panicles. Female flowers sub-solitary or in short clusters. Fruit succulent, indehiscent, 1-celled, of the size of a small melon, with a soft yellow pulp. Seeds numerous, blackish, and covered with a loose hyaline skin or arillus.

Distribution

This plant fruits all the year round, but the fruit is most luscious during the summer. It does not grow well in the drier parts of India, but flourishes where rainfall is high and the climate hot. All other species of the genus are American.

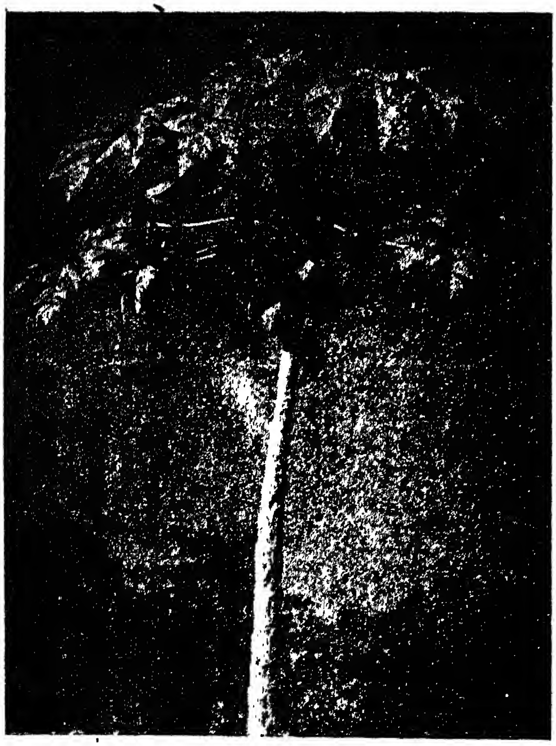

FIG. 98. *Carica papaya* Linn.

Uses and properties

The milky juice of the fruit, which can readily be collected by scarification of the unripe fruit, is considered to have medicinal properties.

It is said to be a powerful anthelmintic, though in Jamaica it is considered to have injurious effects on the gastro-intestinal tract. It is extremely acrid and produces irritation and blisters if applied to the skin (*1*). It is applied locally as an irritant to the *os uteri* to procure abortion (*2*).

Anthelmintic properties have also been assigned to the seeds. A belief in their powerful emmenagogue properties prevails among all classes of women in Southern India, who assert that, if a pregnant woman partakes of them even in moderate quantities, abortion will result.

Constituents

The latex or milky juice of the unripe fruits, leaves, stem, and roots is astringent, acid in reaction, and has a bitter taste. On allowing the milky juice to stand, a clear liquid separates out which contains the proteolytic enzyme papain and also a milk-curdling ferment. Papain is capable of hydrolyzing proteins into proteoses and peptones in a neutral medium ; it is active between the temperatures of 37° and 70°C, but is destroyed in solution at about 80°C. When dried, the latex can retain its proteolytic activity even at 100°C, papain being one of the very few enzymes which are thermostable. On account of the ability of the juice to hydrolyze proteins, it has found increasing application in the meat industry for rendering tough meat tender. This is brought about by smearing the meat with the latex or with an infusion prepared from the plant.

The leaves contain a glucoside carposide and an alkaloid carpaine (*3*). Younger leaves are specially rich in carpaine (0·25 per cent), while older ones contain much less (0·07 per cent) ; the bark, roots, and seeds contain only traces (*4*).

The seeds are stated to contain a glucoside and a ferment. The glucoside resembles sinigrin, and on hydrolysis yields a volatile pungent body in the same way as mustard (*5*). The seeds are also stated to yield an essential oil containing sulphur and nitrogenous compounds (*6*).

Carpaine

According to Plugge, carpaine depresses the action of the heart and adversely affects the respiration, whilst von Oefele recommends its application as a substitute for digitalis in cardiac diseases (*7*). In amoebic dysentery carpaine is said to have a powerful action qualitatively and quantitatively equal to that of emetine. Subcutaneous injection of 50 mgm of carpaine hydrochloride was effective in the treatment of a case of human amoebic dysentery (*8*).

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Family XXXIX.—CUCURBITACEAE

(Gourd Family)

Botanical characters

Herbs or more rarely shrubs climbing by means of solitary, lateral, spiral, simple or divided tendrils. Leaves alternate, petioled, frequently cordate, simple or palmately or pedately divided. Flowers monoecious or dioecious, yellow or white, racemed and solitary, less commonly panicled. Calyx-tube usually wholly adnate to the ovary; lobes 5 (rarely 3). Petals usually 5, inserted on the calyx-limb, united in a tube or nearly or quite free. Stamens inserted on the calyx-tube, usually 3 (sometimes 5 or 2); anthers free or connate, one usually 1-celled and the other two 2-celled, cells straight or variously curved or twisted. Ovary inferior, 3-carpellary, usually 1-celled, the three parietal placentas often however meeting and filling up the ovarian cavity, or ultimately 3-celled; style 1 with 3 large stigmas, rarely styles 2–4. Fruit a berry, entirely succulent or finally with a hard rind, rarely entirely dry, indehiscent or dehiscing by valves or by a stopple, often 1-celled. Seeds usually many, often packed in pulp or fibre, often compressed, exalbuminous.

Distribution

In the warmer parts of the whole globe, especially in the tropics.

Economic aspects

The fruits of many plants of this family are of economic value, and it contains a number of vegetables and fruits in common use. Some of the common examples are: 'palval' (*Trichosanthes dioica* Roxb.), bottle gourd (*Lagenaria vulgaris* Ser.), sponge gourd [*Luffa cylindrica* (Linn.) M. Roem., syn. *L. aegyptiaca* Mill. *ex* Hook. *f.*], white gourd-melon [*Benincasa hispida* (Thunb.) Cogn., syn. *B. cerifera* Savi], carilla fruit (*Momordica charantia* Linn.), sweet melon (*Cucumis melo* Linn.), cucumber (*C. sativus* Linn.), melon pumpkin (*Cucurbita maxima* Duchesne), pumpkin (*C. pepo* Linn.), watermelon (*Citrullus vulgaris* Schrad. *ex* Eckl. & Zeyh.), etc. Some of these are also used for medicinal purposes. It is curious that all the above species when in the wild state are stated to produce toxic bitter substances.

The hollowed shell of the dried fruit of *Lagenaria vulgaris* is used as a water bottle, and by the Nagas for holding the rice beer called 'zu'; it is also used for making the stringed musical instrument 'sitar', and wind instruments like the 'bin' of snake-charmers. In some places the hollowed-out gourd is used as a float for crossing rivers.

Toxic aspects

Some of the species are important from medicinal and toxicological points of view. The fruit pulp of colocynth (*Citrullus colocynthis* Schrad.)

is intensely bitter and has a marked purgative action ; an infusion made from this fruit is used in Egypt by the people of the Nile region to smear water bags, in order to prevent camels from biting into them. The basic principle and some of the nonbasic constituents forming the so-called "colocynthin" are responsible for the purgative action of the plant. Colocynthin is excreted in the urine and mother's milk, and should not, therefore, be used by nursing women. The squirting cucumber (*Ecballium elaterium* A. Rich.) is imported from abroad, and is a very powerful hydragogue cathartic and an irritant poison. It contains a neutral principle commonly known as "elaterin", and its poisonous properties have been known from ancient times. Elaterin is one of the most powerful of cathartics and is sometimes used in uraemia. Large doses are likely to produce dangerous prostration and should, therefore, be used with caution. The root of bryony of Europe (*Bryonia dioica* Jacq.) is a drastic purgative and is poisonous. It contains an alkaloid and a resin, both of which are responsible for its purgative action. All the three plants mentioned above contain several active resinous and alkaloidal principles. When taken internally, they produce continuous watery stools with intense irritation and hyperaemia of the gut. Formerly they were largely used to reinforce the action of other purgatives, as in the compound cathartic pills, but their use has decreased considerably of late years. The pulp of *Trichosanthes bracteata* (Lam.) Voigt (*T. palmata* Roxb.) has been stated to be used in India to poison cattle, and that of *T. cucumerina* Linn. as an emetic and drastic purgative. *Cucumis africanus* Linn. *f.* and *C. myriocarpus* Naud. of South Africa, especially their ripe fruits, are very toxic to animals.

Some plants belonging to the genera *Citrullus*, *Cucumis*, *Cucurbita*, *Lagenaria*, and *Luffa* are known to contain saponins, while glucosides have been found in *Bryonia* and *Momordica*.

Very few of the wild species of this family are edible, and the bitter "varieties" particularly must be eaten with great caution. It would appear that some of the members of this family have lost their poisonous properties through cultivation, and have become edible. Some of these, *e.g.*, *Cucurbita pepo* Linn., although extensively used as an article of diet, may at times be poisonous.

The fruits of this family are often laxative, sometimes very bitter, strongly emetic, and cathartic. The roots are occasionally acrid and act as drastic purgatives. Some of the plants have anthelmintic and emmenagogue properties. The seeds are more or less mucilaginous and oleaginous.

Some of the important constituents isolated from plants of this family are: (*a*) *bitter substances*, such as those found in *Cucumis*, *Ecballium*, *Lagenaria*, *Luffa*, *Momordica*, *Trichosanthes*, etc., (*b*) *saponins*, such as those found in *Citrullus*, *Cucumis*, *Cucurbita*, *Lagenaria*, *Luffa*, etc., (*c*) *glucosides*, such as brionine, and (*d*) *alkaloidal principles*, such as those found in *Bryonia* and *Citrullus*. *Constituents*

KEY TO THE GENERA*

A. Ovules horizontal. Female flowers usually solitary, never panicled. Leaves not divided into distinct leaflets.

- I. Anther-cells conduplicate or sigmoid. Corolla divided nearly or quite to the base into 5 petals.
  - *a*. Petals fimbriate at their margin. Seeds many. Calyx-tube less than 3 in. .. .. 7. *Trichosanthes*.
  - *b*. Petals entire.
    - *aa*. Calyx-tube of the male flower elongate; anthers usually included in the tube or nearly so. Fruit very large. Tendrils divided. Petiole with two glands at apex .. .. 4. *Lagenaria*.
    - *bb*. Calyx-tube of the male flower short; anthers usually exserted from the tube or nearly so.
      - 1. Stamens inserted near the mouth of the calyx-tube; anthers hardly or not at all cohering.
        - *i*. Male flowers (partly) in racemes. Fruit opening by a stopple .. 5. *Luffa*.
      - 2. Stamens inserted below the mouth of the calyx-tube; anthers more or less cohering.
        - *i*. Male flowers (partly) racemed. Tendrils simple .. .. 6. *Momordica*.
        - *ii*. Male flowers clustered or solitary. Tendrils simple 3. *Cucumis*.
        - *iii*. Flowers all solitary. Tendrils 2-3-fid .. .. 1. *Citrullus*.
- II. Anther-cells straight. Fruit circumsciss near the base .. .. 2. *Corallocarpus*.

B. Ovules pendulous. Flowers small, the females in racemes. Stamens 5, free, each with a single small straight anther. Fruit long clavate. Seeds winged. Leaves entire .. .. 8. *Zanonia*.

BRYONIA Linn.

(From the Greek *bryonja*, from *bryein*—to swell, to sprout; referring to the quick growth of the stems.)

Bryonia dioica Jacq. (bryony) is a climbing plant with pretty coloured flowers. It is found in Europe. The roots of this plant have been found to contain traces *Economic and toxic aspects*

* Some species of *Bryonia* and *Ecballium* are used in medicine and are imported into India. These plants are, therefore, also discussed in detail.

of an essential oil, a resin, a bitter glucoside "brionine", and traces of an amorphous alkaloid (*1*). The resinous material of the root as well as the products obtained by its successive extraction with light petroleum, ether, chloroform, and ethyl acetate produced marked purgation in doses of 1 gm. The alkaloidal principle has an intensely bitter taste, and in doses of 0·1 gm produces slight purgation (*2*). The purgative property of the root cannot, therefore, be attributed to a single definite principle, but may be assumed to reside chiefly in the alkaloidal and resinous constituents. The preparation which was regarded as a glucoside by previous workers and was designated as "bryonin" must have been a complex mixture, the constituents of which were not entirely glucosidic in nature. According to Jensen, the fresh bryony root is much more poisonous than the dried one and yields a large quantity of the active substance only in late autumn (*3*).

Another foreign species, *B. cretica* (Tourn.) Linn., has been found to have a depressant action on the heart as well as on the plain muscle. The resin given by mouth to dogs produces gastro-intestinal irritation. The minimum lethal dose is 100 mgm of the dry extract per kgm subcutaneously for rabbits and 75 mgm per kgm intravenously for dogs (*4*).

The pharmacological action of white bryony (*B. alba* Linn.), another foreign species, has been studied. The extract of the root produced impairment of the action of frog's heart, which denoted relaxation of the muscular tone. In mammals (cats and dogs) the extract produced a fall of blood pressure (*5*).

1. CITRULLUS Forsk.

(A diminutive formed from the Latin *citrus*, the citron tree; in allusion to the resemblance in fruit.)

Botanical characters

Usually prostrate and trailing, hispid or scabrous herbs; tendrils 2–3-fid, rarely undivided. Leaves palmately or pinnatifidly 3–7-lobed, the lobes sinuately pinnatifid. Flowers monoecious, all solitary, tolerably large, yellow. Calyx-tube broadly campanulate; lobes 5. Corolla 5-partite beyond the middle. Stamens 3, short; anthers scarcely cohering, cells conduplicate or sigmoid, connective not produced. Style short, with 3 reniform stigmas. Fruit globose or ellipsoid, smooth, fleshy, indehiscent. Seeds oblong, compressed, smooth.

Distribution

Tropical regions of Asia and Africa, and round the Mediterranean; wild and also cultivated.

Toxic aspects

Citrullus colocynthis Schrad. and the bitter varieties of other members of this genus contain bitter resinous principles, which cause purgation.

KEY TO THE SPECIES

a. Perennial. Leaves harshly scabrid. Fruit 2–3 in. diam. 1. *C. colocynthis.*
b. Annual. Leaves glabrous or somewhat hairy, hardly scabrid. Fruit up to 10 in. diam. .. 2. *C. vulgaris.*

1. Citrullus colocynthis Schrad.

Fl. Brit. Ind., II, 620.

(Bitter Apple, Bitter Cucumber, Colocynth, Coloquintide)

Vernacular names: ARABIC—Aulqum, Habzal, Hamzal, Humzil; BALUCHISTAN—Kurkushta; BENGAL—Indrayan, Makal, Makhal; BOMBAY—Indrayan, Kaddu-kankri; BURMA—Khiasi, Khiati, Kiyasi; DECCAN—Henzil, Indrawan; GUJERAT—Indrak, Indranan, Indravana, Indravanan, Indravarana, Indravarnan,

Indravena, Tras, Trunadeda; HINDI—Ghorumba, Indrayan, Makal; KANARESE—Pavamekke-kayi, Tumti-kayi; MALAYALAM—Peykommutti; MARATHI—Indraphal, Indravana, Indrayan, Kadu-indrayan, Kadu-vrindavana, Thorli-indrayan; PERSIAN—Hindavanahe-talkh, Kabiste-talkh, Kharbuzahe-rubah, Karbuzahe-talkh; PUNJAB—Ghorumba, Ghurumba, Inaraunmaraghune, Khartuma, Kustamma, Tumbi, Vishlumba, (Fruit: Hamzel, Indrayan. Seeds: Tukhm-tumma); SANSKRIT—Indralavaruni, Indravaruni, Makhal, Vishala; SIBI—Marghuni, Truh; SIND—Tru-jo-gosht, Tru-jo-par; TAMIL—Peykkumutti, Poykomattitumatti, Peyttumatti, Verikkummatti, Verittumatti; TELUGU—Chittipapara, Etipuchchha, Paparabudama, Patsakaya, Veripuchchha, Veriputsa; URDU—Indrayan.

Botanical characters

A prostrate scabrous herb with perennial root and simple or 2-fid tendrils. Leaves $1\frac{1}{2}$–$2\frac{1}{2}$ by 1–2 in. (larger in the cultivated form), pale-green above, ashy beneath, scabrid on both sides, deltoid, 3–7-

FIG. 99. *Citrullus colocynthis* Schrad.

lobed. Corolla $\frac{1}{4}$ in. long, pale-yellow. Fruit globular, slightly depressed, 2–3 in. diam., variegated green and white, glabrous when ripe, filled

with a dry spongy very bitter pulp; epicarp thin. Seeds $\frac{1}{6}$–$\frac{1}{4}$ in. long, pale-brown, not margined.

Distribution

Found wild in wastelands almost throughout India, particularly in the North-West, Central, and South India.

Uses and properties

This plant is not systematically cultivated anywhere in India, but the fruits are collected in the cold season by herbalists from wild plants. The roots and the whole fruit without seeds are commonly used in India, whereas the dried pulp of the unripe fruit only is official in British Pharmacopoeia. Colocynth is very bitter and is used in medicine as a drastic purgative; it is a constituent of some of the purgative pills of modern pharmacy. The dried and powdered pulp of the fruit is used as a purgative in doses of 2 to 8 grains. In indigenous medicine, colocynth is used in the treatment of snake poisoning, dropsy, dysentery, and amenorrhoea. In large doses it acts as an acro-narcotic poison and has caused deaths in several instances in Europe. Christion (*6*) mentions a case where one and a half teaspoonfuls of the powder (about 90 grains) proved fatal; and Taylor (*7*) cites the case of an adult female who took 120 grains of the powder to produce abortion, and died in fifty hours. A case of recovery from a dose of 3 ounces has, however, been reported (*8*). Toxic dose of colocynth is 0·6 to 1 gm, while about 4 gm is fatal.

All parts of the plant are bitter, and the dust when dry is irritating to the eyes and nostrils.

Constituents

The fruit pulp of colocynth contains traces of an essential oil, a dihydric alcohol designated as citrullol, a weakly basic alkaloidal principle, and some resinous material. This resinous material further yields α-elaterin, hentriacontane, a phytosterol, fatty acids, and other resinous substances of indefinite character. The amount of glucosidic substance contained in the fruit is extremely small.

The purgative action of colocynth is due to at least two principles, one of which is alkaloidal or basic, while the other is represented by some nonbasic constituents contained in both ether and chloroform extracts of the resinous material (*9*). The bitter principle consisting of the nonbasic constituents is commonly known as "colocynthin," and this term has been responsible for a very considerable confusion. The fact must be appreciated that the so-called "colocynthin" and "colocynthitin", as well as the other products obtained from colocynth to which specific names have been attached by various workers consist of mixtures of an indefinite character.

The basic principle as well as the ether and chloroform extracts of the resin produce drastic purgation in dogs in doses of 0·1 gm (*9*). The

constituents forming the bitter principle from an Indian specimen were present to the extent of not less than 2 per cent by weight of the dry pulp (*10*).

The seeds of colocynth, which represent about 75 per cent of the entire peeled fruit, were found to contain traces of an alkaloidal principle, a fatty oil, and a small amount of an enzyme (*9*).

The root contains α-elaterin, an amorphous saponin, and some resins (*11*).

2. Citrullus vulgaris Schrad. *ex* Eckl. & Zeyh.

Fl. Brit. Ind., II, 621.

(Watermelon)

Vernacular names: ARABIC—Batighe-hindi; BALUCHISTAN—Hinduana, Mehal; BENGAL—Tarbuza, Tarmuj; BOMBAY—Kalinga, Kalingad, Pharai, Turbuj; BURMA—Paye, Phayaithi; GUJERAT—Karinga, Tarbuch, Turbuch; HINDI—Halinda, Hindwana, Karbuj, Samanka, Tarbuz, Tarbuza, Turmuz; KOLAMI—Tarboj; KONKANI—Kaling; MARATHI—Kalingada, Tarbuj; PERSIAN—Dilpasand, Hinddanah, Kachrehn; PUNJAB—Haduana, Hadvana, Matira, Tarbuj; SANSKRIT—Brihadgold, Chayapula, Tarambuja, SIND—Chauho, Karigo, Kirbut, Meho; TAMIL—Pitcha, Pullum; URDU—Tarbuz.

Botanical characters

A climbing (or prostrate) annual with bi- or tri-fid tendrils. Leaves 3–8 in. long, deeply divided or but moderately lobed, glabrous or somewhat hairy, hardly scabrid. Corolla yellow within, greenish outside and villous; lobes prominently 5-nerved. Fruit up to 10 in. diam., subglobose or ellipsoid, smooth, greenish or clouded, often with a glaucous waxy coating; flesh juicy, red or yellowish-white. Seeds usually margined.

Distribution

Indigenous to tropical Africa, but now extensively cultivated throughout India and in most warm countries for its delicious fruit.

Uses and properties

The watermelon has either a sweet or a bitter fruit; when the latter, it is *C. amarus* of some authors. Some Indian authors do not draw this distinction when considering the drastic purgative properties of the fruit. The sweet fruit is commonly eaten in hot weather without its purgative qualities being evident. The bitter or the wild form has an intensely bitter taste and certainly has purgative properties. It seems possible, therefore, that the sweet form owes its freedom from poisonous properties to cultivation.

Constituents

The pulp of the bitter fruit is said to contain a "bitter principle" which is toxic. The seeds contain a fatty oil, a phytosterol, traces of tannin, an alcohol (cucurbitol), resins, etc., but none of the components administered to dogs produced any toxic effect (*12*).

2. CORALLOCARPUS Welw. *ex* Benth. & Hook. *f.*

(In allusion to the *coral*-red fruits.)

Botanical characters

Climbing or prostrate, scabrid or subtomentose herbs with simple tendrils. Leaves roundish-cordate, entire, lobed or palmate. Flowers very small, monoecious; males crowded at the apex of a long peduncle; females short-pedicelled or subsessile, solitary or clustered. Calyx-tube campanulate; lobes 5, short. Corolla 5-partite. Stamens 3, free, inserted on the calyx-tube; filaments very short; anther-cells straight. Ovary ovoid, few-ovuled; stigma 3-, rarely 2–4-lobed. Berry fleshy, ovoid or ellipsoid, usually beaked, circumsciss near the base. Seeds few, obovoid or subglobose, tumid.

Distribution

In India and tropical Africa.

Corallocarpus epigaeus (Rottl. & Willd.) C. B. Clarke

Fl. Brit. Ind., II, 628.

Vernacular names: ARABIC—Azanul-fil; DECCAN—Garajphal, Rakkas-gaddah; GUJERATI—Kadvinai, Nahikunda; HINDI—Akas-gaddah, Rakas-gaddah; KANARESE—Akashagaruda-gadde; MALAYALAM—Kadamba, Kollankova; MARATHI—Kadavinai, Karmugli, Karvina; PERSIAN—Lufa; SANSKRIT—Katunahi; TAMIL—Akasha-garudan, Gollankovai; TELUGU—Muru-donda, Naga-donda.

Botanical characters

Prostrate or climbing herb from a tuberous rootstock. Leaves $\frac{3}{4}$–3 in. long, usually a little broader than long, suborbicular, angled or more or less deeply 3–5-lobed, shortly roughly hairy on both sides. Corolla greenish-yellow; segments $\frac{1}{24}$ in. long. Female flowers usually solitary; peduncle short, stout. Fruit stalked, $\frac{1}{2}$–1 in. long (including the beak), ellipsoid or ovoid, suddenly contracted into a slender beak $\frac{1}{4}$ in. long, scarlet in the middle, the base and beak green, circumscissilely dehiscent at the junction of the green and red portions near the base. Seeds 6–9, in orange-coloured pulp, pyriform, $\frac{1}{8}$–$\frac{1}{6}$ by $\frac{1}{12}$–$\frac{1}{10}$ in., brown, with a whitish corded margin.

Distribution

Found in the Punjab, Sind, Gujerat, Rajputana, Southern Mahratta Country, the Deccan, Carnatic, and the lower hills of the Ghats, in dry country.

Uses and properties

The root resembles that of *Momordica dioica* Roxb. *ex* Willd., and is not unlike a badly grown turnip though much larger. It varies in thickness and length. It is yellowish white externally and marked with raised circular rings. Its taste is bitter, mucilaginous, and subacid. When cut, it exudes a viscid juice which soon hardens into an opalescent gum. It is a drug valued in India as an alterative tonic in old syphilitic

infections and other conditions of similar nature. It has also been used in some parts in the treatment of dysentery and snake bite.

FIG. 100. *Corallocarpus epigaeus* (Rottl. & Willd.) C. B. Clarke

The bitter principle, according to Dymock (*13*), is probably allied to " bryonin ". The root is used as a drastic purgative in doses of about one drachm in twenty-four hours.

3. CUCUMIS (Tourn.) Linn.

(Etymology obscure.)

Annual herbs or with a perennial root, climbing or trailing, hispid or scabrous; tendrils simple. Leaves palmately 3–7-lobed or 5-angled or entire, dentate or serrate. Flowers yellow, monoecious, males clustered in the axils (rarely solitary), females solitary, all shortly peduncled. Calyx-tube turbinate or campanulate; lobes 5. Corolla *Botanical characters*

deeply 5-partite. Stamens 3; anthers free, cells conduplicate or much flexuose, connective produced into a crest above the anther. Ovary ovoid; style short, with 3 obtuse stigmas. Fruit fleshy, indehiscent, large or small, spherical or elongate, smooth or tuberculate. Seeds oblong, compressed, mostly smooth.

Distribution

In tropical regions, especially in Africa; several species are widely cultivated.

Toxic aspects

Much confusion still exists with regard to the so-called wild and cultivated species and varieties of this genus found in India.

The foreign species *C. africanus* Linn. *f.* and *C. myriocarpus* Naud., especially their ripe fruits, are toxic. *C. myriocarpus* has emetic and purgative properties (*14*). The poisonous principle is nonglucosidal and probably of a resinous nature; it is highly toxic to animals when given by mouth or by subcutaneous or intravenous injections; the symptoms vary according to the route of administration. Large toxic doses given by mouth kill by producing acute pulmonary oedema, the gastro-enteritis being less marked. Given subcutaneously or intravenously, it produces marked dyspnoea accompanied by cyanosis, the animal dying within one or two hours from asphyxia (*15*).

C. africanus (*16*) contains the same resinous principle, but the yield is only one third to one half of that obtained from *C. myriocarpus*.

KEY TO THE SPECIES

a. Annual. Leaves hairy, angled or shallowly lobed. Fruit hispid or muricate .. .. .. 1. *C. sativus*.

b. Perennial. Leaves scabrid, deeply palmately lobed. Fruit smooth .. .. 2. *C. trigonus*.

1. Cucumis sativus Linn.*

Fl. Brit. Ind., II, 620.

(Cultivated and wild Cucumber)

Vernacular names: Bengal—Khira, Sasa; Burma—Tha-gwa, Tha-khwa-the; Gujerat—Kakari, Kankdi, Tansali; Hindi—Khira; Kanarese—Saute-kayi; Konkani—Kankri, Toushe; Madras—Vellari; Marathi—Kakdi, Khira, Tavase; Mundari—Bakri-taear, Taear; Persian—Shiyare-khurd; Punjab—Kakri, Khira, Khiyar; Sanskrit—Sukasa, Trapusha; Tamil—Muhevehri, Piping-kay; Telugu—Doza-kaya; Uriya—Kaknai, Kakri.

Botanical characters

A hispidly hairy climber. Leaves about 4½ in. diam., membranous, deeply cordate, angled or shallowly 3–5-lobed, both sides hairy with softish hairs but the upper with thickened bases, ribs beneath scabrid

*Haines (*17*), from whose work the botanical description of this plant is abstracted, points out that this probably refers to feral forms.

or hispid, margin denticulate. Flowers ¾–1 in. across; males clustered. Fruit cylindric, covered with harsh hairs or soft spines and finally more or less muricate*.

Distribution

Cultivated in all warm and warm temperate countries; also found wild in Northern India.

Uses and properties

Royle's *C. hardwickii* does not differ from *C. sativus* Linn. in any essential respect and cannot be treated as a separate species. It is thought to be a wild state of the commonly cultivated and largely eaten *C. sativus* Linn., and is found wild from Kumaon to Sikkim. At the same time it bears separate vernacular names and is collected and sold for so very different purposes that it deserves independent notice. It is known as 'air-alu' in Kumaon and as 'pahari-indrayan' in the hill tracts bordering on the plains. It is often spoken of as "hill colocynth," and is said to possess properties similar to those of the official colocynth.

It has been said that the juice banishes wood lice and fish insects; for this purpose freshly cut slices are strewn in their haunts.

Constituents

The fruits contain a proteolytic enzyme resembling erepsin (*18*). They also contain a bitter substance the nature of which has not been ascertained.

2. Cucumis trigonus Roxb.

Fl. Brit. Ind., II, 619.

Vernacular names: BENGAL—Ban-gumak, Gomuk; GUJERATI—Kothiban; HINDI—Bhakura, Bislambhi, Bislombi, Gorakha-kakadi, Jangli-indrayan, Songha; KONKANI—Karatim, Karit; MARATHI—Karita, Shendada, Takamake; MUNDARI—Bhais-dimbu, Bhaisi-dimbu, Bing-dimbu, Bir-dimbu, Gusa-dimbu, Gusi-dimbu, Hatu-dimbu, Hon-dimbu, Huring-dimbu, Jaiti-dimbu; PUNJAB—Kachri, Kakri; SANSKRIT—Garakshi-vriksha, Godumba; SIND—Chiber; TAMIL—Hattuttumatti; TELUGU—Adavi-puchcha, Kodi-budama, Kodi-budinga, Nalla-budama, Nalla-budinga, Pam-budinga, Pulcha; UNITED PROVINCES—Bishlumbhi, Indrayan.

Botanical characters

A scabrid perennial with rough slender stems. Leaves 1–2 in. long and broad (sometimes larger), suborbicular, deeply palmately 5–7-lobed, cordate, scabrid (including the petiole); lobes rounded at the apex, lobulate or dentate. Male flowers in small clusters, rarely solitary. Ovary hairy. Fruit ellipsoid or subglobose, 1½ by 1¼ in., ultimately smooth, longitudinally variegated with 10 green stripes, pale-yellow when ripe; pulp bitter. Seeds white, ellipsoid, not margined.

Distribution

Found throughout the greater part of India.

Uses and properties

The bitter pulp is used as a substitute for colocynth and is a drastic purgative. The decoction of the root is considered to be a mild

* The fruit of several of the cultivated varieties is smooth.

purgative, producing less irritation. Waddell (*8*) mentions a case, which was reported to the Bombay Chemical Analyzer's Office in 1833,

FIG. 101. *Cucumis trigonus* Roxb.

in which it was stated that the root of this plant had been administered for inducing abortion.

Constituents

The fruit contains colocynthin or a substance of a similar nature (*19*).

ECBALLIUM A. Rich.

(From the Greek *ekballein, ek*—out of, and *ballein*—to throw; referring to the fruit which bursts from the stalk when ripe, forcibly ejecting the seeds.)

Ecballium elaterium A. Rich.

(Squirting cucumber)

Uses and properties

This plant is a native of South Europe and is cultivated in Britain and South Europe. The fruit is 1½ to 2¼ in. long, oblong-ovoid, pale yellowish-green, and covered with numerous, short, fleshy prickles terminating in white elongated points. When ripe it separates suddenly from the stalk, violently expelling the juice and the seeds. In indigenous medicine it is considered to have narcotic properties, and is used in the treatment of malaria and hydrophobia.

The fruit is sold in India under the name of 'kateri-indrayan' and yields the elaterium (elaterin) of commerce, which is a powerful hydragogue cathartic. The commercial elaterium, which is the sediment from the expressed juice of the fruit, is used in medicine as a purgative in doses of one-sixteenth to half a grain. One grain has caused severe symptoms, but probably more would be required to cause death (*8*).

Constituents

The fruits contain phytosterol, a dihydric alcohol, a mixture of fatty acids, etc., and a crystalline powder corresponding to the product known as "elaterin" in the British and United States Pharmacopoeias. This product, which is nonhomogeneous, consists of two crystalline substances, *viz.*, 60 to 80 per cent of the laevorotatory elaterin, designated as α-elaterin, which is devoid of any physiological action, and a dextrorotatory elaterin, designated as β-elaterin, having intensely purgative properties. The view that a glucoside of elaterin is present in the juice of the fresh fruit is denied by Power and Moore who have definitely ascertained that the so-called "elaterin" exists in the fruit as such and not in a combined state (*20*, *21*). Commercial elaterin is variable in composition and activity.

4. LAGENARIA Ser.

(From the Latin *lagena*—a flask; referring to one of the shapes of the fruit of the only species, the bottle gourd.)

Botanical characters

Large herbaceous climbers, pubescent; tendrils 2-fid. Leaves ovate or orbicular, cordate, dentate; petiole long, with 2 glands at the apex. Flowers large, white, solitary, monoecious or dioecious, the males long- the females short-peduncled. Calyx-tube funnel-shaped subcampanulate; teeth 5, narrow. Petals 5, free, obovate. Stamens 3; anthers connate, included, cells conduplicate. Ovary oblong; style short, with 3 bifid stigmatic lobes. Fruit large, ultimately thick membranous or almost woody, indehiscent, polymorphous. Seeds numerous, compressed, smooth, with a marginal groove.

Distribution

Palaeotropics.

Lagenaria vulgaris Ser.

Fl. Brit. Ind., II, 613.

(Bottle Gourd, Calabash, Long-necked Gourd, Pilgrim's Gourd, Trumpet Gourd)

Vernacular names: ARABIC—Kare-hulmar; ASSAM—Boga-lao; BENGAL—Kodu, Kodu-lau, Kadu, Lau, Tikta-lau; BIJNOR—Gol-kaddu; BURMA—Businswai; GUJERATI—Dudhi, Dudio, Kadvi-tumbadi, Tumada; HINDI—Al-kaddu, Gol-kaddu, Kaddu, Kadu-tumbari, Kadu-tumbi, Kashiphal, Lau, Lauka, Lauki, Mithi-tumbi, Tita-lau, Tumri; KATHIAWAR—Dudhiyun, Dudhlun;

KOLAMI—Suku; KONKANI—Dudi, Dudio, Mardudi; KUMAON—Lauka, Tumri; MALAYALAM—Bella-shora; MARATHI—Bhopla-bija, Dudh-bhopala, Dudhya, Kadu-bhopla; MUNDARI—Birsuku, Kendera-suku, Kendra-suku, Tumba-suku; NAGA—Mekuri; NEPAL—Konkra, Phusi; PERSIAN—Kaddu, Kaddu-shirin, Kaddu-talkh; PUNJAB—Ghiya, Gol-kaddu, Kabuli-kaddu, Keddu, Lauki, Tumba; SANSKRIT—Alabu (cultivated form), Katu-tumbi (wild form); SANTAL—Kadu; SIND—Hurrea-kaddu, Irao, Kaddu; TAMIL—Shorakkai; TELUGU—Alabuvu, Anapakaya, Anugakaya, Kubbakaya, Kundanuga, Nelanuga, Sorakaya; UNITED PROVINCES—Kaddu, Lau, Lauki; URAN—Loewa; URDU—Kaddu-gol, Tumbari.

Botanical characters

A large, climbing or trailing herb. Leaves often 6 in. diam., softly pubescent on both surfaces, more or less 5-angular or 5-lobed., Male peduncle often 6 in., female 1 in. Petals 1-2 in. Fruit often 1½ ft., usually bottle- or dumbbell-shaped.

Distribution

Found wild in India and is also extensively cultivated for its young fruits.

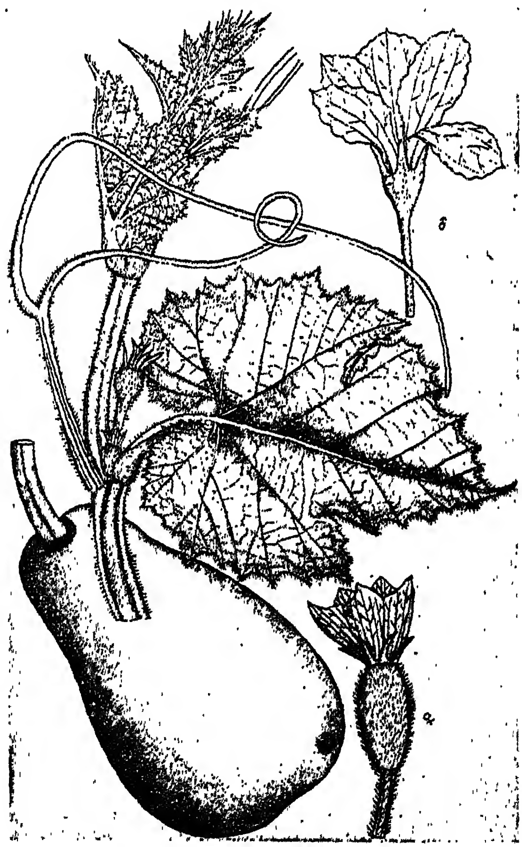

FIG. 102. *Lagenaria vulgaris* Ser.

Uses and properties

The fruits assume many shapes as the result of cultivation, the most remarkable of these being the pilgrim's gourd (in the form of a bottle), the long-necked gourd, the trumpet gourd, and the calabash; the last one is generally large, round, and devoid of a neck. The bottle gourd is sometimes as much as 6 ft. in length.

The flesh of the cultivated form differs from that of the wild variety; the former is sweet and edible, and the latter bitter, unpalatable, emetic, and purgative (often excessively so), resembling *Citrullus colocynthis* Schrad.

The dried shell of the wild form is made into musical instruments, bottles, etc. It is stated that some sailors were once poisoned by drinking beer which had been standing in a hollowed bottle gourd (*22*), the symptoms produced being similar to those of cholera (*8*). Dymock (*13*) also mentions that the poisonous symptoms observed with this plant are similar to those of poisoning by elaterium and colocynth. The pulp of the wild form is emetic and purgative, and is used by farriers in the Punjab as a purgative for horses. It is sometimes used as an application in scorpion sting. The leaves also have a purgative action.

Constituents

The seeds are said to contain saponins (*23*).

5. LUFFA (Tourn.) Linn.

(From the Arabic name *luff* of vegetable sponge.)

Botanical characters

Annual climbers; tendrils 2–5-fid. Leaves cordate, usually 5-angular or 5-lobed; petiole without glands at the apex. Flowers monoecious, rarely dioecious, rather large, yellow or white, males and females often from the same axil; males racemose or clustered; females solitary or panicled. Calyx-tube campanulate or top-shaped, that of the female produced beyond the ovary; lobes 5. Petals 5, obovate. Stamens 3, rarely 5; anthers exserted, free, cells sigmoid, often on the margin of the broad connective. Ovary oblong; style cylindric; stigma 3-lobed. Fruit oblong (not spherical), smooth or angular or spinous, not succulent, ultimately dry and fibrous within, 3-celled, usually opening by a stopple. Seeds many, oblong, compressed.

Distribution

Warmer regions of the world; several species are widely cultivated.

Toxic aspects

The fruit and ripe seeds are violent cathartics and emetics.

KEY TO THE SPECIES

A. Stamens 5. Seeds winged, usually smooth .. .. 2. *L. cylindrica*.
B. Stamens 3.
  a. Fruit 10-ribbed. Seeds rugose, wingless .. 1. *L. acutangula*.
  b. Fruit echinate. Seeds slightly verrucose, wingless 3. *L. echinata*.

1. **Luffa acutangula** (Linn.) Roxb., var. **amara** C. B. Clarke

Fl. Brit. Ind., II, 615.

Vernacular names: BENGAL—Ghosha-lata, Jhinga, Tita-jhinga, Tito-dhundul, Tito-jhinga, Tito-torai; BOMBAY—Kadu-dorka, Kadu-sirola; DECCAN—Karvi-turai; GUJERAT—Jhumkhadan, Kadvan-turian, Kadvi-ghisodi, Vad-gisodi; HINDI—Jhimani, Karvi-tarui. Karvi-turi, Sankirah; KANARESE—Kaduhire; MALAYALAM—Athanga; MARATHI—Divali, Dodka-turai, Kadu-dodaka, Kadu-dodaki, Kadu-shirali, Kadu-turai, Ran-turai, Shirala, Shirol; PERSIAN—Turai-talkh; PUNJAB—Kali-tori; SANSKRIT—Koshataki, Vanya; TAMIL—Peyppirkam; TELUGU—Adavi-bira, Chedu-bira, Sendu-bir-kai, Verri-bira; UNITED PROVINCES—Kerula; URDU—Bandal.

Botanical characters and distribution

Luffa acutangula (Linn.) Roxb. is very closely allied to *L. cylindrica* (Linn.) M. Roem. from which it differs in having 3 stamens and a strongly ribbed ovary. The fruit is 6–12 in. long., clavate-oblong, tapering towards the base, very obtuse, smooth, longitudinally ribbed (almost winged) with 10 sharp angles. Seeds $\frac{1}{2}$ by $\frac{1}{4}$–$\frac{1}{3}$ in., ovoid-oblong, much compressed, slightly corrugated on the sides, not winged, black.

FIG. 103. *Luffa acutangula* (Linn.) Roxb.

It is cultivated throughout the greater part of India, and its unripe fruit is largely eaten as a vegetable. It is, however, the wild variety *amara* which is of toxicological interest and which is found throughout India especially in the western area. The leaves are smaller, at first whitish and softly villous, finally scabrid. Flowers are also smaller than in the type. The fruit is obovoid, obtusely conical at both ends, 2–4 in. long by about 1–1½ in. thick, 10-ribbed, bitter; seeds smaller.

Uses and properties

Every part of the wild variety is remarkably bitter. The fruit is violently emetic and purgative, and is not eaten. *L. acutangula* (Linn.) Roxb. is cultivated all over India and its seeds are described as emetic and purgative.

Constituents

The fruits contain an amorphous bitter substance. The seeds contain a purgative oil—luffa-seed oil; the pressed cake from the seeds is bitter and toxic (*23*).

2. Luffa cylindrica (Linn.) M. Roem.

L. aegyptiaca Mill. *ex* Hook. *f.*, Fl. Brit. Ind., II, 614.

(Dishcloth Gourd, Sponge Gourd, Towel Gourd, Vegetable Sponge, Washrag Gourd, Washrag Sponge)

Vernacular names: ARABIC—Luff, Luffa; ASSAM—Bhat-kakrol, Bhat-kerela, Bhol; BENGAL—Dhundul, Dundul, Hastighasha; BOMBAY—Ghiya-turai, Ghosale, Ghosali, Gonsali, Parosi, Parula, Turi; BURMA—Tha-bwot, Tha-pwot-kha; CENTRAL PROVINCES—Dilpasand, Teldoaka; GUJERAT—Kalaka, Martigonsali, Turia; HINDI—Ghia-tarui, Nenua, Purula; KONKANI—Porgonsali, Porgousali; KUMAON—Dhandal, Ghiya-taroi, Tarod, Turail; MADRAS—Tureippirku; MARATHI—Ghada-ghosali, Ghosali, Paroshi; NEPAL—Palo; PERSIAN—Khujar; PUNJAB—Ghia-tori, Ghigandoli; SANSKRIT—Dirghapatolika, Rajakoshataki; SIND—Liasada, Turi; TAMIL—Pichukku, Pikku; TELUGU—Gutti-bira, Neti-bira; Nune-bira; UNITED PROVINCES—Ghiya-taroi, Ghiya-tori; URDU—Turai, Turi.

Botanical characters

An extensive climber reaching considerable height. Leaves 4–8 in. long, often broader than long, orbicular-reniform, palmately 5- rarely 7-lobed, finely scabrous, punctate. Male flowers in axillary 4–20-flowered racemes, usually crowded near the top of the raceme; petals yellow with green veins; stamens 5. Female flowers solitary; ovary cylindric-oblong. Fruit 5–12 in. long, cylindric or somewhat trigonous, blunt at the end, marked with longitudinal lines. Seeds black or grey, ⅜ by ¼ in., much compressed, narrowly winged, smooth or slightly tubercled.

Distribution

This plant is cultivated or naturalized in most hot countries of the world. In India, it is common everywhere and is often cultivated, especially in the plains.

Uses and properties

The dry fruit, which is filled with an interwoven network of fibre, is used as a bath sponge in India and elsewhere.

The fruit juice of the plant has been described as a drastic purgative (*24*). and is toxic (*25*). This evidently refers to the wild variety which is bitter and not edible. The cultivated forms are commonly eaten as a vegetable in many parts of India, and are not toxic. The seeds are considered in Indian literature to have emetic and cathartic properties like those of *L. acutangula* (Linn.) Roxb.

Constituents

The fruits contain a saponin and much mucin (*26*).

3. Luffa echinata Roxb.

Fl. Brit. Ind., II, 615.

Vernacular names: BENGAL—Bindal, Deyatada; BOMBAY—Kukad-vel, Kukar-vel, GUJERATI—Kukara-vel, (seeds=Wa-upla-bij); HINDI—Bidali, Ghagara-bola, Ghusarana, Khaksi, Sonaiya, Vandala; KANARESE—Devadangar; MARATHI—Devadali, Devadangari, Kukda-vel, (seeds=Deodagri); SANSKRIT—Koshataki; SIND—Jangthori; TELUGU—Pani-bira; URDU—Kukara-bel.

Botanical characters

Climbing but not extensively. Leaves $1\frac{1}{2}$–$2\frac{1}{2}$ in. long, usually a little broader than long, reniform-suborbicular, broadly cordate, obscurely 5-angular or more or less deeply 5-lobed. Flowers usually dioecious, small, white; stamens in male flowers 3. Fruit broadly ellipsoid, 1–$1\frac{1}{2}$ by $\frac{1}{2}$–$\frac{3}{4}$ in., not ribbed, densely covered with ciliate bristles $\frac{1}{6}$–$\frac{1}{4}$ in. long; operculum conical, without bristles. Seeds $\frac{1}{6}$–$\frac{1}{5}$ by $\frac{1}{8}$ in., not winged, slightly verrucose.

Distribution

Found in Gujerat, Sind, Bihar, Bengal, North Oudh, Bundelkhand, Dehra Dun, and many other places.

Uses and properties

The fruit contains a bitter substance called "luffein", which causes purging and vomiting in the same way as colocynth (*13*). In indigenous medicine it is used as an emetic and anthelmintic, and in the treatment of hiccough, jaundice, and phthisis.

6. MOMORDICA (Tourn.) Linn.

(From the Latin *mordere* or *momordisse*—to bite; alluding to the seeds which look as if bitten.)

Botanical characters

Climbers with simple tendrils. Leaves cordate, entire, lobed or pedately 3–7-foliolate. Flowers yellow or white, monoecious or dioecious, females solitary, peduncled, males solitary or racemed, bracteate or not. Calyx-tube short, campanulate, closed at the bottom with 2–3 incurved oblong scales, 5-lobed. Corolla 5-partite nearly to the base. Stamens 3 (2 in *M. tuberosa* Cogn.); filaments short, free; anthers at length free. the cells flexuose (rarely short and straight or

curved). Style long; stigmas 3. Fruit oblong or spherical, rough or smooth, indehiscent or 3-valved, many- or few-seeded. Seeds tumid or flattened, smooth, corrugate or sculptured.

Distribution Chiefly African, but scattered throughout the tropics of both the hemispheres.

Toxic aspects The fruits and the seeds are violent cathartics and hydragogues.

KEY TO THE SPECIES

A. Male peduncle 1-flowered.
- *a*. Bracts of the male flowers very near the top of the peduncle .. .. 1. *M. balsamina.*
- *b*. Bracts of the male flowers about or below the middle of the peduncle .. .. .. 2. *M. charantia.*

B Male peduncle 2–5-flowered .. .. .. 3. *M. tuberosa.*

1. Momordica balsamina Linn.

Fl. Brit. Ind., II, 617.

(Balsam Apple, Balsamina)

Vernacular names: ARABIC—Mokah; CENTRAL PROVINCES—Mokha; GUJERATI—Chhochhidan; HINDI—Mokha; SIND—Kurelo-jangro.

Botanical characters Glabrous or nearly so. Leaves 1½–3 in. diam., orbicular, palmately 3–5-lobed to about the middle, lobes acutely lobulate, punctulate on both surfaces. Flowers monoecious. Male flowers solitary with an orbicular, denticulate, variegated bract very near the top of the peduncle; petals ¼–½ in., yellowish, black at the base. Fruit 1–3 in., ovoid, narrowed to both ends, rostrate, red, smooth or obscurely ribbed and slightly muricate. Seeds compressed, nearly smooth.

Distribution Met with in the Punjab plains, Sind, Gujerat, and the Deccan; also reported from Dehra Dun.

Uses and properties The fruit is occasionally employed in medicine in India and elsewhere as an application for chapped hands, burns, haemorrhoids, etc. It is also said to be eaten in India and South Africa in the form of a pickle or as a vegetable.

A few drachms of the fruit are fatal to a dog when given by mouth (*27*), while Pammel (*71*) states that the plant has emetic properties. Obviously some forms are poisonous while others are harmless.

2. Momordica charantia Linn.

Fl. Brit. Ind., II, 616.

(Carilla Fruit)

Vernacular names: ARABIC—Qisaul-barri, Ulhimar; ASSAM—Kakiral, Kakral; BENGAL—Baramasiya, Jethuya, Karala, Poti-kakar, Uchchhe; BURMA—Ka-hin-ga-bin, Kyet-henkha; CENTRAL PROVINCES—Karli: DECCAN—Karela;

GUJERAT—Karela, Kareolo, Karelu, Korela; HINDI—Karela, Kareli, Karola; KANARESE—Hagola, Hagala-kayi; KOLAMI—Kirla; KONKANI—Karatim; KUMAON—Kurela; MALAYALAM—Kaippa, Kappakka, Panti-pavel, Pavakka-chetti; MARATHI—Karale, Karli; MUNDARI—Karaili, Karla; PERSIAN—Karelah, Sima-hang; PUNJAB—Karela, Karila; SANSKRIT—Karavella, Sushavi; SIND—Karelo; TAMIL—Pakal, Pavakka-chedi, Pava-kayi; TELUGU—Kakara, Metta-kakara, Tella-kakara, Ura-kakara; UNITED PROVINCES—Karela, Karola; URDU—Karela; URIYA—Kalera, Karela.

Botanical characters

A softly hairy rather slender climber. Leaves 1–5 in., almost orbicular, pedately 5–7-fid or -sect, the segments again lobulate or sinuate-dentate. Flowers monoecious, yellow, about $\frac{1}{2}$ in. across; males solitary with an orbicular entire bract near the middle or lower portion of the peduncle. Fruit 1–5 in., pendulous, ovoid or fusiform, rostrate, covered with triangular tubercles, yellow when ripe. Seeds compressed, with corrugate margins.

Distribution

Largely cultivated throughout India for its young fruits, of which there are several cultivated forms, differing in shape and size.

FIG. 104. *Momordica charantia* Linn.

Uses and properties

The fruits are eaten as a vegetable or in the form of pickles. They are generally salted or steeped in salt water before cooking, and in this way much of the bitterness is removed.

The whole plant is used for medicinal purposes in India. The leaves have purgative, emetic, and bitter properties.

A case of death from violent vomiting and purging, caused by the administration of the juice of the plant to a child, has been reported (*28*). In India, the roots are stated to be used successfully for procuring abortion (*8*). A case, wherein abortion was produced in the seventh month by swallowing a decoction of the roots of this plant, has been reported (*29*).

Constituents

The leaves contain a bitter substance "momordicin", resins, two resin acids, etc. (*23*). The plant contains about 0·038 per cent of an alkaloid (*30*), and the seeds yield about 32 per cent of a purgative oil (*31*).

3. Momordica tuberosa Cogn.

M. cymbalaria Fenzl *ex* Naud., Fl. Brit. Ind., II, 618.

Vernacular names : MARATHI—Kadavanchi, Kadvanchi.

Botanical characters

Tuberous perennial with very slender scandent stem. Leaves 1–2 in. broad, orbicular-reniform, shortly 5–7-lobed, deeply cordate, punctate but not scabrid. Flowers monoecious. Male flowers in 2–5-flowered racemes; corolla pale-yellow, with $\frac{3}{8}$–$\frac{1}{2}$ in. long segments; filaments 2, one 2-fid one 3-fid so each with 1 anther-cell. Stigmas 2, spreading, 2-partite. Fruit $\frac{3}{4}$–1 in. long, pyriform or broadly fusiform, narrowed into the curved peduncle, dark-green, 8-ribbed, sparsely hairy. Seeds $\frac{1}{8}$–$\frac{1}{4}$ in. long, broadly ovoid, strophiolate, not margined, shining, dark-brown.

Distribution

Found in the western parts of India from Satara district in the north down to Tinnevelly in the south.

Uses and properties

The whole plant is acrid, and the ovoid tuberous roots are reported to have been used for inducing abortion (*28*), a decoction being administered for this purpose.

Constituents

The tubers are said to contain a bitter glucoside (*13*).

7. TRICHOSANTHES Linn.

(From the Greek *thrix, trichos*—hair, and *anthos*—a flower; referring to the fringed, nearly free corolla-lobes.)

Botanical characters

Scandent herbs with entire or 3–9-lobed denticulate leaves and usually 2–5-fid rarely simple tendrils. Flowers white, males usually racemose (rarely solitary) with a solitary female or male at the base from the same axil, or females separate and solitary. Calyx elongate-tubular, dilated above, 5-lobed. Petals 5, fimbriate, nearly free. Stamens 3; anthers almost included, connate (free in *T. dioica* Roxb.), cells

conduplicate. Fruit fleshy, globose, ovoid or fusiform, smooth. Seeds many, usually margined.

Distribution

Tropical Asia, North Australia, and Polynesia.

Economic and toxic aspects

The fruit is considered to have anthelmintic properties; the seeds are bitter and astringent, sometimes emetic and purgative. The roots sometimes act as a cathartic.

KEY TO THE SPECIES

A. Bracts of the male raceme large, sheathing the flowers from a broad base .. .. .. 1. *T. bracteata.*

B. Bracts 0 or minute.

a. Longer male peduncle with a raceme of flowers .. 2. *T. cucumerina.*

b. Both male peduncles with single flowers. Anthers free 3. *T. dioica.*

1. Trichosanthes bracteata (Lam.) Voigt

T. palmata Roxb., Fl. Brit. Ind., II, 606.

Vernacular names: ARABIC—Anbaghol, Hanzale-ahmar; BENGAL—Makal; DECCAN—Gudapandu, Koundel, Lal-indravam, Lal-indrayan; GARHWAL—Ilaru, Indarain; GUJERATI—Ratan-indravanan; HINDI—Indrayan, Lal-indrayan, Mahakal, Makal; KANARESE—Avagude-hannu; KOLAMI—Kaubutki; KONKANI—Komdol; KUMAON—Indrayan; MALAYALAM—Kakatorti; MARATHI—Kaundal, Kavandala, Mukal; PERSIAN—Hanzale-surkh, Koshta; RANIKHET—Indarain; SANSKRIT—Mahakala; TAMIL—Anakoruthay, Ankorattai, Korattai, Shavari-palam, Shavari-pazham; TELUGU—Abuba, Abuva, Aguba, Avaduta, Avaguda, Donda, Kaki-donda; UNITED PROVINCES—Indrayan, Lal-indrayan, Makhal, Palval, Parvar; URDU—Indrayan; URIYA—Ma-kirla.

Botanical characters

A robust-stemmed climber often reaching 30 ft. Leaves $2\frac{1}{2}$–5 in. long and about as much broad, variable, usually palmately 3–5-lobed to about the middle (more or less), frequently with dark-coloured circular glands scattered along the lower side. Bracts of the male raceme 1 in. or more long, broadly ovate, fringed. Fruit $1\frac{1}{2}$–2 in. in diam., globose, red when ripe, with 10 orange streaks; pericarp thick. Seeds ellipsoid, smooth, not margined.

Distribution

Common in moist thickets from the Himalayas to Ceylon, ascending to an altitude of 5,000 ft.

Uses and properties

In indigenous medicine, the fruit is used in the treatment of asthma and the root is used in the treatment of lung diseases of cattle.

The bright-red fruit of the wild plant is not edible, owing to its violently purgative properties, but under cultivation it becomes a wholesome vegetable provided it is well boiled. Its poisonous properties appear to be removed by pickling. It is also said to be mixed with rice occasionally and in this way employed to destroy crows (*28*). The root is stated to be poisonous (*17*), and has been stated to be used as a cattle poison (*8*).

It is said to contain a bitter principle named "trichosanthin" (13). *Constituents*

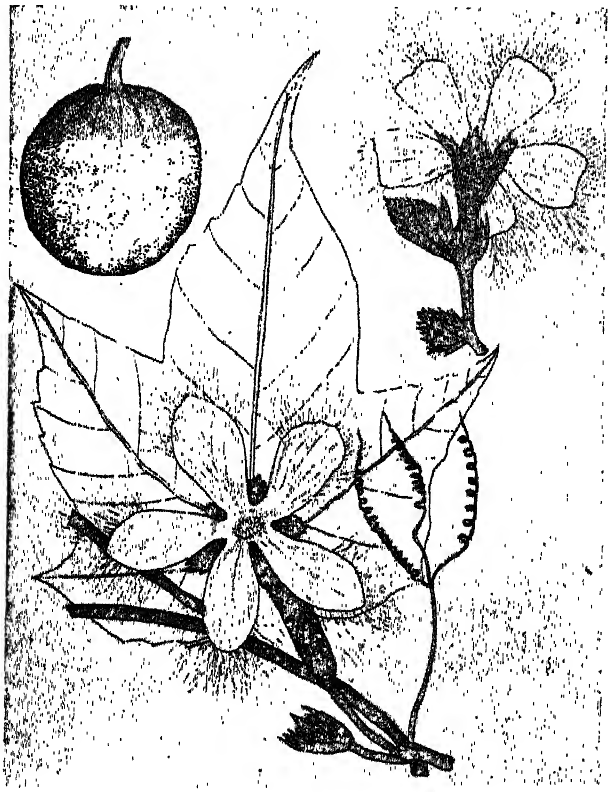

FIG. 105. *Trichosanthes bracteata* (Lam.) Voigt

2. Trichosanthes cucumerina Linn.

Fl. Brit. Ind., II, 609.

Vernacular names: BENGAL—Ban-chichanga, Ban-patol; BOMBAY—Jangli-padavala, Jangli-padvel, Kadu-padavala, Pudoli, Ran-parul; BURMA—Thabhwot-kha, To-pelen-moyo; GUJERATI—Kadvi-padvela, Kadvi-patola, Padvals, Patola; HINDI—Jangli-chachinda; KANARESE—Bettada-padavala, Kripodla; KOLAMI—Bir-kaita; KUMAON—Jangli-chachinda; MALAYALAM—Kaippam-patolam, Katu-patolam, Patavalam, Pepatolam; MARATHI—Jangli-padavala, Jangli-parela, Kadu-padavala, Perula, Ran-padavala; MUNDARI—Birkaotha, Kaubutuki; PUNJAB—Gwal-kakri, Mohakri; SANSKRIT—Patola; TAMIL—Kattu-peyppudal, Pudel, Peyppudal; TELUGU—Adavi-potla, Chedupotla, Cheti-potla, Chya-potta, Patolamu, Patolas; UNITED PROVINCES—Banpatol, Jangli-chichinda, Jangli-chichonda, Kandori, Patol; URDU—Patol.

A slender climber. Leaves 2–5 in. long, cordate, orbicular-reniform or broadly ovate, more or less deeply 5- (rarely 3–7-) lobed; lobes denticulate, not acuminate. Male flowers in axillary racemes, with *Botanical characters*

sometimes a solitary male flower from the same axil as the raceme; bract absent. Fruit 1–3 in. long, ovoid-fusiform, tapering at both ends and with a long sharp beak, green and striped with white when immature, scarlet when ripe: pericarp thin. Seeds half-ellipsoid, rugulose, embedded in red pulp.

Distribution

Found on hedges and bushes throughout India.

Uses and properties

Every part of this plant is used in medicine. It is considered a drastic purgative and emetic in Indo-China. In indigenous medicine in India, it is used as a laxative, alterative, and tonic. The juice of the leaves is emetic, and the root acts as a poweful cathartic.

3. Trichosanthes dioica Roxb.

Fl. Brit. Ind., II, 609.

Vernacular names: BENGAL—Patol; GUJERAT—Patala; HINDI—Palval, Parvar; MALAYALAM—Patolam; PERSIAN—Palol; PUNJAB—Palval; SANSKRIT—Patola, Putulika; TAMIL—Kombu-pudalai: TELUGU—Kommu-potla; URDU—Paraval; URIYA—Patal.

Botanical characters

An extensive climber with slender, more or less woolly and hispid stems. Leaves 3 by 2 in., ovate-oblong, cordate, acute, sinuate-dentate, not lobed, rigid, rough on both surfaces; petiole scabrous woolly. Male flowers often paired, one short- the other long-peduncled, woolly outside; anthers free. Fruit 2–3½ in., oblong or nearly spherical, orange-red when ripe. Seeds half-ellipsoid, corrugate on the margin.

Distribution

Common throughout the plains of Northern India, from the Punjab to Eastern Bengal and Assam. It is extensively cultivated in the above-mentioned areas for the sake of its fruit.

Uses and properties

The fruit is commonly eaten as a vegetable. The leaves, the fresh juice of the fruit, and the root are all used in indigenous medicine. The leaves are used as a bitter tonic and as a febrifuge. The fruit of the wild form is also bitter and is used as a remedy for scorpion sting. The bulbous part of the root is stated to be a hydragogue cathartic, acting in the same way as "elaterium" and for which it can be substituted (*28*).

8. ZANONIA Linn.

(After G. *Zanoni*, 1615–82, an Italian botanist.)

Botanical characters

Scandent shrubs; tendrils simple or bifid at the apex. Leaves ovate or oblong, entire. Flowers small, dioecious, all racemose or the males panicled. Calyx of 3, rarely 4, sepals, membranous, concave. Corolla rotate, 5-partite, coriaceous or fleshy; lobes narrowed at the apex. Stamens 5, free, inserted on a fleshy disc; filaments very short and thick; anthers 1-celled, transversely oblong. Ovary at first 3-celled, later

1-celled; ovules 2–many in each cell; styles 3, bifid at apex. Capsule cylindric, clavate or hemispheric, terete or subtrigonous, truncate and broadly 3-valved at the apex. Seeds large, pendulous, oblong, compressed, surrounded by a broad membranous wing.

Distribution

Tropical Asia and Java.

Zanonia indica Linn.

Fl. Brit. Ind., II, 633.

Vernacular names: GUJERATI—Parpoti; HINDI—Chirpotana, Chirpoti, Patakona, Shanasokha; MALAYALAM—Penarvalli; MARATHI—Chirabuti, Chirapota, Chirpoti; SANSKRIT—Chirpota, Dirghapatra, Kuntali, Tiktaka.

Botanical characters

A stout scandent shrub climbing to a height of 30–50 ft. Leaves 3–6 by 2–4 in., ovate-oblong, acute, entire, bright-green and glabrous

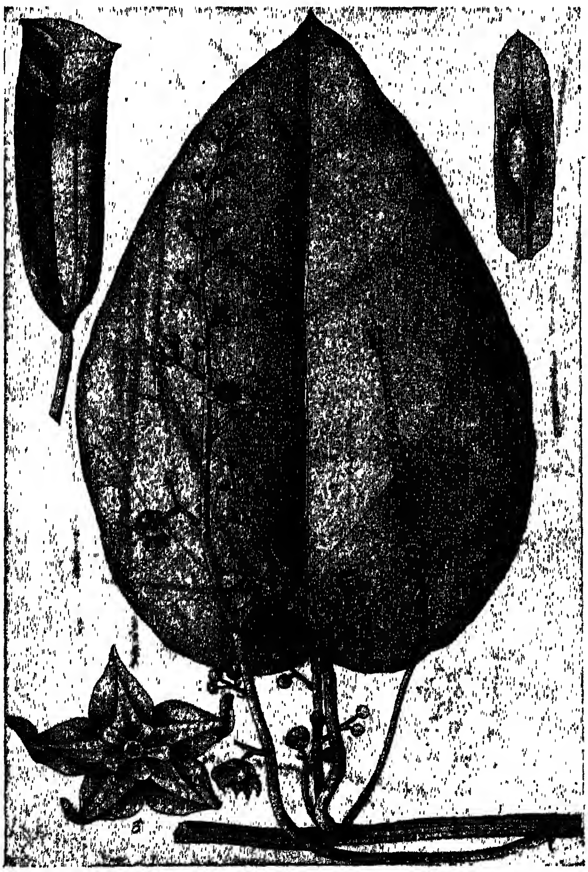

FIG. 106. *Zanonia indica* Linn.

above, paler and conspicuously reticulate beneath, rounded or slightly cordate at base. Male flowers in racemes or panicles 6–12 in. long; petals greenish-yellow, $\frac{1}{6}$ in. long, $\frac{1}{12}$ in. broad at the base. Female flowers in 5–12-flowered racemes 4–12 in. long; petals $\frac{1}{4}$–$\frac{1}{3}$ in. long. Capsule 2–4 in. long, cylindric-obconic, slightly tapering towards a rounded base, truncate at apex, pale yellowish-brown. Seeds pale-yellow, $\frac{3}{4}$ by $\frac{3}{8}$ in.; the wing 2–2$\frac{1}{2}$ in. long by $\frac{1}{2}$ in. broad, rounded at the base and apex.

Distribution

Found in Assam, East Bengal, Malabar Ghats, Mysore, the Deccan, and Konkan.

Uses and properties

The fruit is not eaten and is said to possess very acrid cathartic properties. In indigenous medicine, it is believed to have purgative and antiseptic properties, and is considered to be beneficial in cough, asthma, and as an application for the bites of venomous creatures.

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Family XL.—BEGONIACEAE

(Begonia Family)

Botanical characters

Succulent herbs; stem often reduced to rhizome or tuber. Leaves alternate, more or less unequal-sided; stipules 2. Flowers usually showy, in dichotomous cymes, monoecious, usually bilateral; bracts and bracteoles opposite. Male: Perianth (*Begonia*) of 2 outer valvate segments, and 2–0 inner smaller pair. Stamens many, free or monadelphous. Female: Perianth of 5–2 segments. Ovary (*Begonia*) inferior, 2–4-usually 3-celled; ovules numerous, on axile, simple or divided placentas; styles 2–4, free or connate at base; stigmas branched or tortuous. Fruit usually capsular, often winged. Seeds minute, albumen scanty or 0.

Distribution

In all tropical moist countries; not yet found in Australia.

Begonia (Tourn.) Linn.

(In honour of Michel *Bégon*, French Governor of Santo Domingo and a patron of botany in the seventeenth century.)

Botanical characters

Characters of the family.

Economic aspects

Many species of this genus are highly ornamental plants and great favourites of the modern foliage cultivator. The succulent stems of some of the species are used as potherbs, and, when fresh, have a peculiar acid taste.

Begonia rex Putz.

Fl. Brit. Ind., II, 647.

Botanical characters

Stemless. Leaves 4–6 in., cordate-ovate, acute, unequal at the base, undulate, ciliate-denticulate, pubescent on the nerves beneath. Peduncle upwards, bracts, ovary and flowers glabrous. Scapes 4–9 in.; flowers medium, rose, not very many. Male: Stamens monadelphous, connective produced. Female: Perianth-segments 5, inner gradually smaller. Capsule $\frac{1}{2}$–$\frac{5}{8}$ by 1–$1\frac{1}{4}$ in. including the wings, 2-celled.

Distribution

Found in Assam and Mishmi hills.

Uses and properties

This plant is used by some of the tea planters of Assam as a substitute for rhubarb.

The juice of this plant is poisonous to leeches, and may, therefore, be used to kill them when they are encountered in the nostrils of animals (*1*). The juices of several other species of *Begonia* and that of *Anagallis arvensis* Linn. (of the family Primulaceae) would also seem to be well suited for this purpose

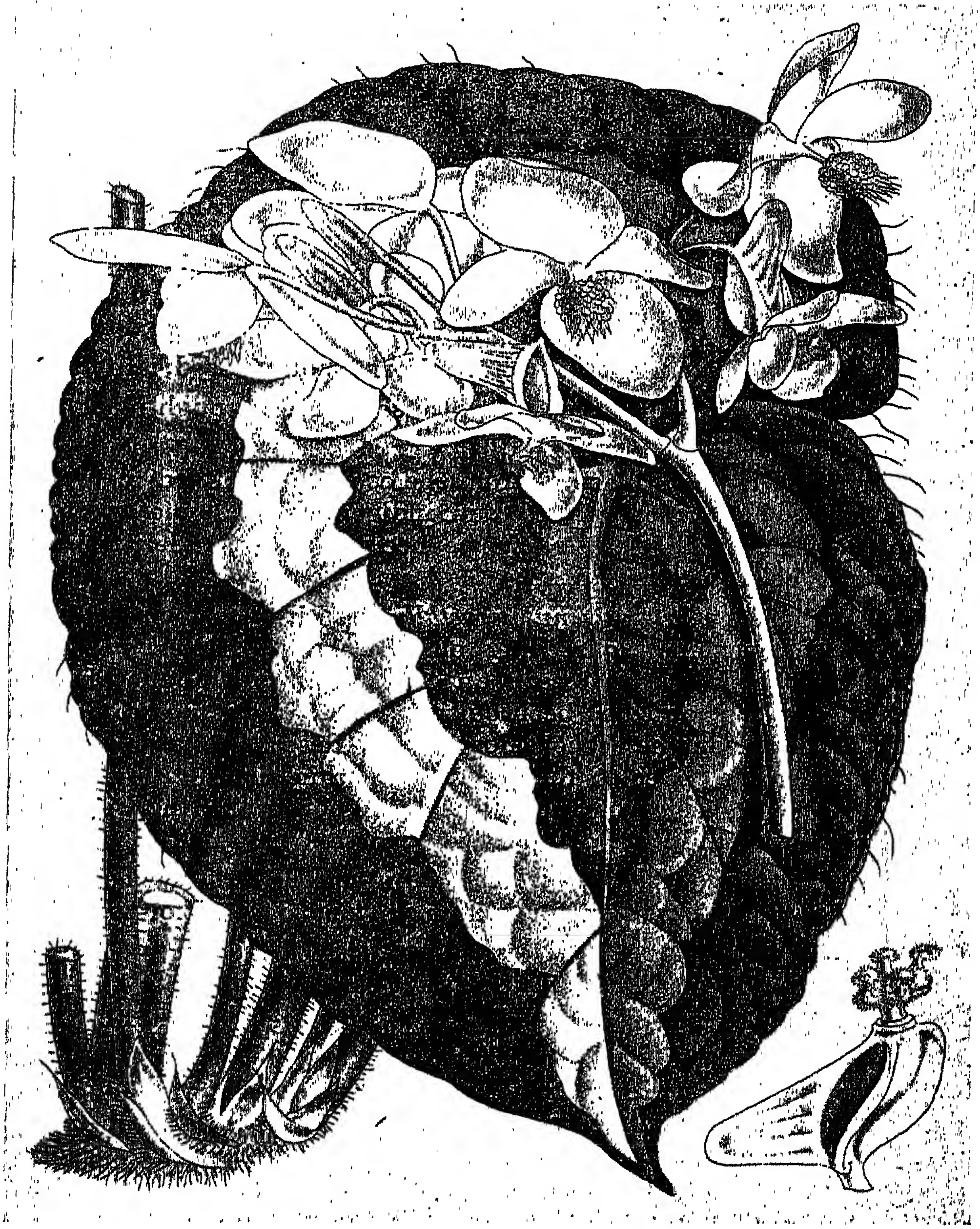

FIG. 107. *Begonia rex* Putz.

REFERENCE

1. Watt : *A Dictionary of the Economic Products of India*, 1889–96, Vols. 1–6.

Family XLI.—AIZOACEAE (Ficoidaceae)

(Ice-plant Family)

Botanical characters

Herbs. Leaves simple, often fleshy, usually opposite or whorled. Flowers usually in cymes or clusters, rarely solitary. Calyx of 4–5 segments, often persistent. Petals usually 0. Stamens perigynous or hypogynous, definite or indefinite. Ovary usually free, 2–5- rarely 1-celled, usually syncarpous; styles as many as carpels; ovules many in each carpel and axile, or solitary basal. Fruit usually capsular, splitting dorsally or circumsciss, rarely separating into cocci. Seeds many or 1 in each carpel, usually reniform, compressed, albuminous.

Distribution

Chiefly inhabitant of Africa, but also scattered through most tropical and subtropical regions.

Economic and toxic aspects

This family is not important from the economic point of view, except that a few of the species are used in indigenous medicine. From the toxicological point of view, reference need only be made to the genus *Trianthema* described hereafter.

Ice plant (*Mesembryanthemum crystallinum* Linn.) is so named because of the numerous small glistening bladder-shaped hairs covering the leaves. It is believed to absorb an extraordinary amount of alkaline salts from the soil, and has been cultivated in America to remove their excess from land on the seacoast or in salty deserts. Large quantities are also said to be collected for making ash which is used in glass manufacture. Other species of the genus are known as sand binders, and should prove useful in the dry plains of North-Western India.

Two foreign plants, *M. tortuosum* Linn. and *M. expansum* Linn., contain the alkaloid mesembrine whose physiological action is not unlike cocaine (*1*).

Trianthema Sauv.

(From the Greek *treis*—three, and *anthema*, from *antheo*—to flower; the flowers are usually disposed in threes.)

Botanical characters

Diffuse prostrate branched herbs. Leaves opposite, unequal, entire, exstipulate; petioles connected at the base by their dilated membranous margins. Flowers small, axillary, sessile or peduncled. Calyx-tube short or long; lobes 5, often cuspidate, coloured within. Petals 0. Stamens 5–10 or more, inserted near the top of the calyx-tube. Ovary 1–2-celled; styles 1 or 2. Capsule clavate, circumsciss, the upper part often carrying away 1 or 2 seeds, the lower portion 2–many-seeded.

Distribution

Tropical and subtropical regions.

KEY TO THE SPECIES

a. Stamens 5. Styles 2	1. *T. pentandra.*
b. Stamens 10 or more. Style 1	2. *T. portulacastrum.*

1. Trianthema pentandra Linn.

Fl. Brit. Ind., II, 660.

Vernacular names: PUNJAB—Bishkapra, Itsit.

Botanical characters

Papillose or nearly glabrous. Leaves 1–1½ in., oblong or elliptic. Flowers in sessile clusters. Calyx-lobes often scarious on the margin. Stamens 5. Styles 2. Capsule ⅙ in.; beak mitriform, separating into 2 lanceolar 1-seeded parts; lower portion of the capsule 2-seeded.

Distribution

A common weed growing on wastelands in the plains of the Punjab, Sind, West Rajputana, Konkan, the Deccan, Southern Mahratta Country, and parts of the United Provinces.

Uses and properties

This plant is considered to be an astringent and is eaten, like the following species, as a potherb in times of scarcity. According to Stewart (*2*), it is believed to cause abortion and is also apt to produce diarrhoea and paralysis.

2. Trianthema portulacastrum Linn.

T. monogyna Linn., Fl. Brit. Ind., II, 660.

(Horse Purslain)

Vernacular names: BENGAL—Gada-bani, Labuni, Sabuni, Shwet-punarnava; BOMBAY—Bishkapra, Khapra, Sweta-punarnava; DECCAN—Nasurijanghi, Nasurjingh, Vurmah; HINDI—Sal-sabuni, Sabuni, Swet-sabuni, Vishakhapara; KANARESE—Muchchugoni; MADRAS—Mukkaratta; MARATHI—Pundhari-ghentuli; NASIRABAD—Visakh; PUNJAB—Bishkapra, Itsit; SANSKRIT—Punaravi; SIND—Narmah; TAMIL—Sharunnai, Shavalai; TELUGU—Ambati-madu, Galijeru, Ghelijehru, Yerra-galijeru.

Botanical characters

A prostrate somewhat succulent herb. Leaves ½–1½ in. long, obovate. Flowers solitary, white or pinkish. Calyx-tube scarious, thin, closely sheathed by the base of the petiole; lobes cuspidate. Stamens 10–20. Ovary truncate; style 1. Capsule ⅕ in., scarious below; beak exerted, carrying away with it 3 of the 6–8 seeds.

Distribution

Common throughout India.

Uses and properties

The roots are stated to have cathartic and irritant properties and are used to induce abortion (*3*); they are also used in the treatment of amenorrhoea. The leaves and stems are eaten as a vegetable, but Atkinson (*4*) states that they sometimes produce toxic effects in the form of diarrhoea and paralysis.

Constituents

The authors have found an alkaloid, water-soluble bases, and potassium salts in this plant (*5*).

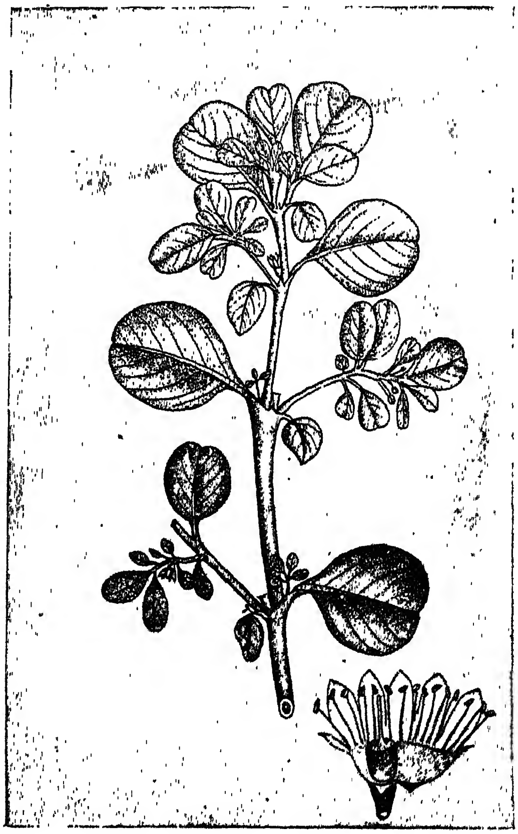

FIG. 108. *Trianthema portulacastrum* Linn.

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2. Stewart: *Punjab Plants*, 1869.
3. Dymock, Warden & Hooper: *Pharmacographia Indica*, 1890–93, Vols. 1–3.
4. Atkinson: *Economic Products of the North-West Provinces*, Part V (Foods), 1878.
5. Chopra, Chatterjee & Ghosh: *Indian J. med. Res.*, 1940, **28**, 475.

Family XLII.—UMBELLIFERAE

(Carrot and Parsnip Family)

Botanical characters

Herbs (Indian species); stems usually fistular. Leaves compound (rarely simple) and often much dissected, alternate, exstipulate; petiole sheathing. Flowers small, hermaphrodite or polygamous, in compound, rarely simple umbels. Calyx-tube adnate to the ovary; limb 5-toothed or 0. Petals 5, sometimes unequal, often bifid, with an inflexed apex and an impressed midrib. Stamens 5, epigynous. Ovary inferior, 2-celled, crowned by a disc; styles 2; ovules 1 in each cell, pendulous. Fruit of 2 indehiscent compressed carpels (mericarps), separated by a commissure and attached to and often pendulous from a slender often forked axis (carpophore). Mericarps with 5 primary ridges and often with 4 secondary ones, 1-seeded; pericarp often traversed by oil-canals (vittae). Seeds albuminous.

Distribution

Cosmopolitan; chiefly in the north temperate regions.

Economic and toxic aspects

This family consists of a large number of plants, many of which are entirely harmless while some of the others are deadly poisons. In general the aromatic members are tonic, stimulant, and carminative, and include several medicinal and kitchen herbs; the nonaromatic members are acrid and narcotic poisons.

A number of the plants are of economic importance. Carrot (*Daucus carota* Linn.) is commonly cultivated in India and elsewhere for the sake of its tuberous root. Celery (*Apium graveolens* Linn.) is commonly cultivated in India for culinary purposes, but in the wild state it is somewhat poisonous. The fruit and leaves of dill (*Peucedanum graveolens* Benth. & Hook. *f.*) are both used to flavour curries, and the medicinal properties of dill oil, dill water, etc., in the preparation of which the fruit is used, are well known. Cumin seeds (*Cuminum cyminum* Linn.) are used in medicine and as a spice. Caraway (*Carum carvi* Linn.), bulbous caraway (*C. bulbocastanum* Koch), and bishop's-weed or lovage [*C. copticum* (Linn.) Benth. & Hook. *f. ex* C. B. Clarke] are known to possess medicinal properties and are also used as spices. *C. copticum* is the well-known source of thymol. Anise (*Pimpinella anisum* Linn.) is met with in the bazars of India, and is cultivated in the north-west. It is the source of the anise oil which is largely used in confectionery. Asafoetida is the dried milky juice of some species of the genus *Ferula* which grow in Tibet and in countries to the north-west of

India: it is used in medicine and also as a flavouring agent for culinary purposes. Fennel (*Foeniculum capillaceum* Gilib., syn. *F. vulgare* Gaertn.) is commonly cultivated in India, and is used in medicine and also for flavouring purposes. Coriander (*Coriandrum sativum* Linn.) is another plant which is used in medicine; the fruits are universally used as a condiment and form one of the chief ingredients of curry pastes and powders and are also employed in confectionery. Parsley [*Petroselinum crispum* (Mill.) Nym. *ex auct.* Kew; syn. *P. sativum* Hoffm. and *Carum petroselinum* Benth. & Hook. *f.*] is frequently cultivated in India for its finely cut leaves, which are used for flavouring dishes mostly by Europeans.

Prangos pabularia Lindl. is a tall perennial herb found in Kashmir and Baluchistan at altitudes of 6,000 to 11,000 ft. The fruit of this plant is reputed to be stomachic, carminative, emmenagogue, and diuretic. It is available in Indian bazars under the names 'komal' or 'badian-i-kohi'. The roots are used as a remedy for itch. Watt (*1*) records that the plant is poisonous to the lower forms of life, a decoction of it being destructive to snails. It might prove to be a good antiseptic wash.

The water dropwort (*Oenanthe crocata* Linn.) with its parsnip-like roots and *O. phellandrium* Lam. are poisonous European plants. Water hemlock (*Cicuta virosa* Linn.) from Europe and Kashmir is very poisonous. Most deadly of all is the spotted hemlock (*Conium maculatum* Linn.) which is a common plant in Europe and in the temperate climes of Asia. The whole plant has a "marshy" odour and is poisonous. It owes its toxicity to a number of alkaloids of which coniine is the most important; it produces death by paralysis of the respiratory centre.

Constituents

The following are some of the important chemical constituents found in the plants of this family: (*a*) *Essential oils* containing (*i*) *hydrocarbons* and *terpenes*, such as p-cymene, limonene, pinene, phellandrene, etc., (*ii*) *alcohols*, such as geraniol, borneol, etc., (*iii*) *phenols* and *phenolic ethers*, such as anethole, thymol, dill-apiole, etc., (*iv*) *aldehydes* and *ketones*, such as anisic aldehyde, cuminic aldehyde, anise ketone, carvone, fenchone, etc., (*v*) *acids*, such as anisic acid, valeric acid, etc., (*vi*) *sulphur compounds*, such as disulphides, etc., (*b*) *alkaloids* and *bases*, such as coniine, N-methyl-coniine, conhydrine, ψ-conhydrine, γ-conicëine, daucine, etc., (*c*) *glucosides*, such as apiin, moschatin, kellin, etc., (*d*) *toxic substances*, such as cicutoxin, cicutoxinin, oenanthotoxin, etc., and (*e*) *saponins*.

KEY TO THE GENERA*

A. Leaves simple, orbicular or reniform, stipulate. Umbels simple.

- *a*. Flowers red. Mericarps with 7–9 ridges, the primary and secondary similar reticulate between; pericarp thick .. .. 2. *Centella*.
- *b*. Flowers white. Mericarps with 3 ridges, the commisural obscure; pericarp thin .. .. .. 5. *Hydrocotyle*.

B. Leaves divided. Umbels compound.

- *a*. Umbels leaf-opposed; bracts and bracteoles 0. Primary ridges of fruit distinct, filiform, secondary ridges 0 .. 1. *Apium*.
- *b*. Bracts 0; bracteoles small. Primary ridges of the fruit thick, corky .. .. 3. *Cicuta*.
- *c*. Bracts pinnate. Fruit bristly. Secondary ridges prominent .. .. 4. *Daucus*.

1. APIUM (Tourn.) Linn.

(From the Celtic *apon*—water; a habitat name.)

Botanical characters

Glabrous herbs. Leaves pinnate, 3-partite or decompound. Umbels compound, often leaf-opposed. Bracts and bracteoles (Indian species) 0. Flowers white. Calyx-teeth obsolete. Petals acute, tip inflexed. Fruit orbicular or elliptic, slightly longer than broad, laterally compressed; carpels semi-terete, subpentagonal, plane on the inner face; primary ridges distinct, filiform; secondary 0; furrows 1-vittate.

Distribution

Cosmopolitan.

Apium graveolens Linn.

Fl. Brit. Ind., II, 679.

(Celery)

Vernacular names: ARABIC—Karafs; BENGAL—Randhuni; CUTCH—Budi-ajiwan; GUJERATI—Bodi-ajamoda; HINDI—Ajmud, Bori-ajmud, Karafs; MARATHI—Ajmoda; PERSIAN—Karasb; PUNJAB—Bhut-jhata; SANSKRIT—Ajamoda; URDU—Ajmod.

Botanical characters

Biennial; stem 1–8 ft., branched. Radical leaves pinnate, with large deeply lobed segments; cauline 3-partite; segments once or twice trifid, coarsely toothed. Peduncle 0–$\frac{1}{4}$ in., leaf-opposed. Umbel-rays 5–10; pedicels 6–16. Fruit $\frac{1}{16}$–$\frac{1}{12}$ in.; ridges narrow; vittae broad.

Distribution

This plant is found at the foot of the North-Western Himalayas and outlying hills of the Punjab. It is cultivated in different parts of India during the cold weather, chiefly as a garden crop in the vicinity of towns for use as a salad and as a potherb. Sometimes it is cultivated in Bengal for its seed and in the Punjab for its root.

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* Preparations of *Conium maculatum* Linn., a foreign plant, are imported into India for use in Western medicine. This plant is, therefore, also discussed in detail.

Uses and properties

The fruits of this plant are eaten as a spice. The green leaves and stalks are eaten or used as an ingredient of soups. A form of it, the turnip-rooted celery, is eaten as a vegetable. Watt (*1*) and Pammel (*2*) state that in the wild state the plant is irritant and somewhat poisonous.

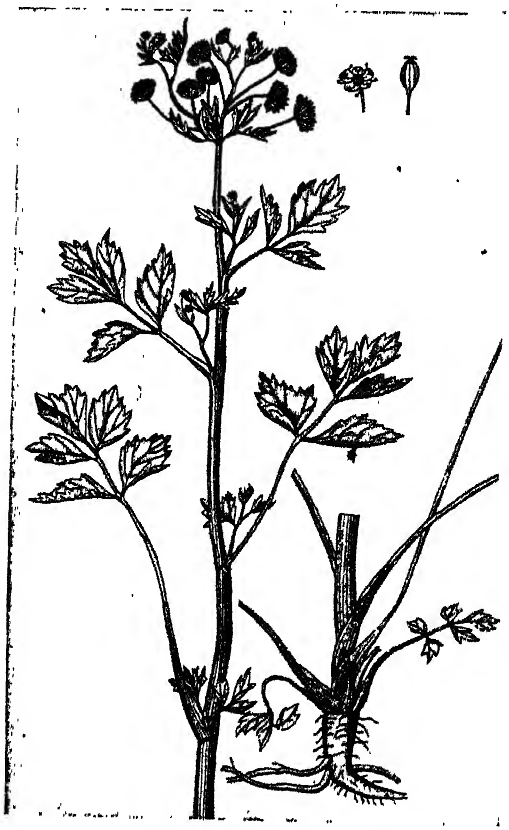

FIG. 109. *Apium graveolens* Linn.

Constituents

The herb contains the glucoside apiin (*3*) and an essential oil (*4*). The tubers contain very little of this oil (*21*), but fruits contain 2 to 3 per cent (*4*). The constituents of the essential oil are: d-limonene 60 per cent, d-selinene 10 per cent, sedanolid 2·5 to 3 per cent, alcohols 2·5 to 3 per cent, sedanonic acid anhydride 0·5 per cent (*4*), and small quantities of the camphor apiole (*5*).

Apiole, which is commercially obtained by alcoholic extraction of the dried fruits of parsley [*Petroselinum crispum* (Mill.) Nym. *ex auct.* Kew], has a decided efficacy in primary amenorrhoea or deficiency of secretion,

as well as in dysmenorrhoea. Toxic polyneuritis frequently follows its administration due to the presence in it of tri-ortho-cresyl-phosphate. The use of this compound in the preparation of a synthetic ginger extract gave rise to an epidemic of peripheral motor paralysis of legs and arms in the south-east of the United States in 1930, in which some 20,000 persons were affected before the cause was discovered. Very few deaths resulted, but partial recovery occurred only after some months, and in many cases paralysis was permanent (5).

2. CENTELLA Linn.

(Etymology obscure.)

Botanical characters

Habit of *Hydrocotyle*, with orbicular, deeply cordate, crenate palminerved, long-petioled leaves; stipules scarious. Flowers reddish, small, sessile, in simple axillary few-flowered umbels; involucral bracts 2, small. Calyx truncate. Petals very small, imbricate. Fruit laterally compressed; mericarps with about 7–9 subsimilar ridges, secondary ridges as prominent as the primary, reticulate between them; vittae 0; pericarp thickened

Distribution

In wet places in tropical and temperate regions.

Centella asiatica (Linn.) Urban

Hydrocotyle asiatica Linn., Fl. Brit. Ind., II, 669.

(Asiatic Pennywort, Indian Pennywort, Marsh Pennywort, Pennywort, Waternavel).

Vernacular names: ARABIC—Artaniyan-hindi, Jharniba; ASSAM—Manimuni; BENGAL—Than-kuni, Thul-kuri; BOMBAY—Brahmi, Karinga, Karivana; BURMA—Minkua-bin, Minkhua-bin; DACCA—Bhika-purni; DECCAN—Vallari; GUJERAT—Barmi; HINDI—Brahmamanduki, Brahmi, Khula-khudi; KANARESE—Vondelaga; MALAYALAM—Kodagam, Kutakam, Muthal; MARATHI—Brahmi; MUNDARI—Kokeara; PERSIAN—Sarde-turkistan; PUNJAB—Brahmi; SANSKRIT—Brahmamanduki, Mandukaparni; TAMIL—Vallarai; TELUGU—Babassa, Bekaparnamu, Bokkudu, Manduka-bramha-kuraku, Pinna-elaki-chettu; URDU—Barhmi.

Botanical characters

Trailing and rooting herb. Leaves ½–2½ in., orbicular-reniform, more or less cupped, entire, crenate or lobulate, glabrous. Peduncle about ¼ in., often 2–3-nate; pedicels 0; bracts small, embracing the flowers, not scattered among the pedicels. Flowers 3–6 in each head, sessile, red. Fruit ⅛–⅙ in., mericarps longer than broad, curved, 7–9-ridged, secondary ridges as prominent as the primary, reticulate between them; pericarp much thickened. Seed compressed laterally.

Distribution

Found in marshy places throughout India, from the Himalayas to Ceylon at altitudes up to 6,000 ft.

Uses and properties

This plant has been used as an alterative, tonic, and is considered useful in diseases of the skin, nervous system, and the blood. It has been recommended in secondary and tertiary syphilis, and in rheumatism. Watt (*1*) mentions the case of Dr. Boileau who, in treating himself, pro-

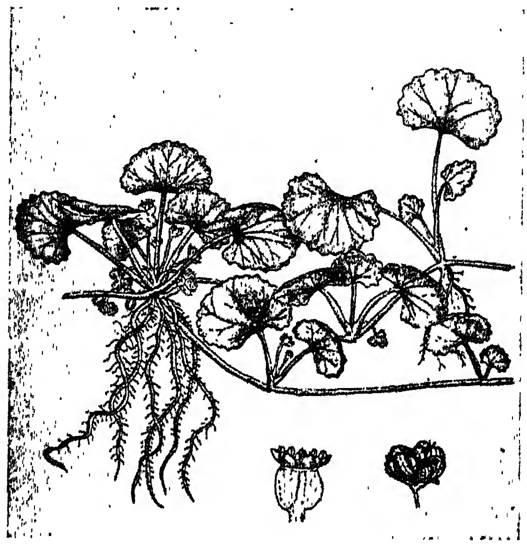

FIG. 110. *Centella asiatica* (Linn.) Urban

gressively increased the dose and found that after two months the drug had produced all the effects of a violent, cumulative poison. He sums up by saying that the plant, properly prepared and administered, is a powerful stimulant of the circulatory system, its action chiefly affecting the vessels of the skin and mucous membrane. In larger doses it is a stupefying narcotic, and in some cases produces cephalagia or vertigo with a tendency to coma. Pammel (*2*) also states that the plant is narcotic.

Constituents

Clement Daruty, quoted by Watt (*1*), confirmed the presence of vellarin, which is an inspissated oil of a pale-yellowish colour, with a bitter, pungent and persistent taste, and a marked odour of centella, obtained by Lêpine (*6*) in 1855. The oil volatilizes at 120°C, and 0·8 to 1 per cent of it has been found in the dry plant. For medicinal purposes, therefore, it is recommended that the plant should not be dried in the sun or by artificial heat, because by so doing the leaves lose their medicinal properties. Hooper, quoted by Watt (*1*), showed that the leaves contained 8·9 per cent of resinous and oily substances (the latter of a volatile and pungent nature), 24·5 per cent of tannic acid, etc.

3. CICUTA (Tourn.) Linn.

(Etymology obscure.)

Botanical characters

Perennial, glabrous herbs. Leaves usually compound-pinnate. Umbels compound, rays numerous. Bracts 0 or few; bracteoles many, small. Flowers white. Calyx-teeth minute. Petals obovate, emarginate. Fruit ovoid, not longer than broad, subcompresssed, distinctly narrowed at the commissure; carpels semi-terete, dorsally compressed, plane on the inner face; primary ridges broad, corky, obtuse; furrows very narrow, 1-vittate; carpophore 2-partite.

Distribution

In north temperate zone.

Cicuta virosa Linn.

Fl. Brit. Ind., II, 679.

(Cowbane, Water Hemlock)

Botanical characters

Stem 2–5 ft., striate, hollow. Cauline leaves 2–3-pinnate; segments lanceolate, serrate. Peduncle 2–3 in., terminal and leaf-opposed. Bracts 0; bracteoles 2–8; rays often 15; pedicels often 30–40. Fruit $\frac{1}{16}$ in.; lateral primary ridges commisural.

Distribution

Found in marshes and ditches round Srinagar in Kashmir at an altitude of 5,200 ft.

Toxicity

Species belonging to the genus *Cicuta* are reported to be deadly poisons, and it is strange that the extremely poisonous properties of *C. virosa*, the only Indian representative of this genus, have not been recorded in the literature on Indian medicinal plants. Hundreds of men and animals have been poisoned in Europe with this plant. The root is the most poisonous part of the plant, but apparently all parts may contain some poison, especially in the early stages of growth. The American species *C. maculata* Linn., *C. bulbifera* Linn., etc., are also very toxic, and several cases of poisoning in man and livestock due to these plants are reported (*2*).

Constituents

The roots contain cicutoxin (*7*), which is a complex pyrone derivative occurring as an unstable resinous substance (*8*); it belongs to the pharmacologic group of which picrotoxin is the chief representative. Besides cicutoxin, cicutoxinin is also probably present; there is no alkaloid or glucoside (*9*). The seeds yield about 1·2 per cent of an essential oil consisting of cuminol, cymol, etc. (*10*).

Action

Cicutoxin acts slowly, as it is sparingly soluble and is slowly absorbed; but when absorption has once taken place its action is even more violent than that of picrotoxin. The toxic symptoms consist in vomiting,

Symptoms

FIG. 111. *Cicuta virosa* Linn.

prolonged unconsciousness, and very violent convulsions often ending in death.

Lethal dose

The lethal dose of cicutoxin for an average rabbit is 175 mgm and for cats 50 mgm per kgm body weight, when administered by mouth. It acts on some nerve centre in the calamus scriptorius, and death results from asphyxiation and exhaustion (*11*). In children 10 gm of the rhizome may cause death (*12*).

Treatment

The most reliable treatment at present known consists in producing vomiting and allaying convulsions by means of narcotics (*11*). Cathartics are also useful for the elimination of poison. Atropine is the best antidote so far known (*12*). An effective clearance of the stomach of the ruminant animals, however, is not possible. Ordinarily the convulsions in animals cannot be controlled by morphine. Practically very little can be done for animals by way of treatment, although some cases recover without any treatment.

CONIUM Linn.

(From the Greek *koneion*, hemlock.)

Conium maculatum Linn.

(Spotted Hemlock)

Toxicity

This plant is found in Europe and temperate Asia. Its toxic properties were known to the ancients who used it to poison criminals condemned to death; it is said that Socrates was poisoned by it. Several cases of poisoning among children and livestock due to the eating of this plant are on record. It was formerly used in therapeutics, but of late its use has been limited.

Constituents

All parts of the plant are poisonous and contain the alkaloids coniine, n-methyl-coniine, γ-coniceine, conhydrine, and ψ-conhydrine. The fruits yield the largest amount of the alkaloids and may contain as much as 2·0 per cent of total alkaloids provided they are collected before they are fully ripe. By prolonged storage of the fruits the percentage of the alkaloids may be reduced to less than 0·1. The alkaloidal values (expressed as total hydrochlorides) from various parts of the plant are as follows: stem 0·01 to 0·06 per cent, leaves 0·03 to 0·18 per cent, flowers 0·086 to 0·236 per cent, green fruits 0·725 to 0·975 per cent (*13*). The alkaloids are found in greater quantity in young leaves; they then gradually decrease and finally disappear (*14*).

Conium and coniine hydrobromide have a direct sedative effect on the respiratory centre; poisonous doses produce death by asphyxia. They are employed in all spasmodic affections, especially against whooping cough and asthma. They are also considered useful as sedatives in neuralgia, epilepsy, and in acute mania.

Poisoning in man

The general symptoms induced in man by poisonous doses of coniine are weakness, languor, and a drowsiness which does not pass into actual sleep. Paralysis of the motor nerve endings of the striated muscles and paralysis of the spinal cord are most prominent. The paralysis takes an ascending course, and in most cases intelligence remains clear to the end. The breathing becomes weaker and slower, and death occurs from arrest of respiration.

Poisoning in animals

In horse there is nausea, gritting of teeth, accelerated respiration and dyspnoea, muscular trembling beginning first in the posterior limbs, difficulty in walking and paralysis, loss of sensibility, low temperature, rapid pulse, and death by arrest of respiration.

In ox there is salivation, arrest of digestion, constipation, and profound stupor; the respiration is rapid. In some instances bloody stools have been observed (*15*).

In sheep the abdomen is tucked up, the appearance of the animal is as if dazed, the pupils are dilated, gait is unsteady, the hind limbs are dragged, and death usually occurs after convulsive movements (*16*).

This plant is liable to be eaten by livestock, particularly in early spring. Sheep have been stated to be comparatively insusceptible, but several cases of poisoning in sheep are also on record. According to Cornevin, 4 to 5 pounds of the fresh plant will kill a horse, and from 8 to 10 pounds an ox (*17*).

Post-mortem appearances.—As regards the alimentary tract, these are not characteristic, as the poison is not an irritant, but some congestion may be observed. The right heart is distended, the left almost empty.

Treatment

Treatment consists in evacuation of the stomach and purgation. Tannic acid may be given to convert the alkaloid into an insoluble tannate. Warmth and stimulants, such as strychnine, atropine, and alcohol, are also indicated.

4. DAUCUS (Tourn.) Linn.

(Form the Greek *daukos* or *daukon*, a kind of parsnip or carrot.)

Botanical characters

Herbs, usually hispid. Leaves 2–4-pinnate, ultimate segments narrow or small. Umbels compound, rays usually many; bracts many, pinnate; bracteoles many or 0. Petals emarginate, white. Fruit elliptic, terete or somewhat dorsally compressed; ridges all prominent, all or secondary only bristly, lateral primary little developed; vittae solitary, under the secondary ridges; carpophore undivided or 2-fid. Seed ½-terete, dorsally subcompressed, inner face plane.

Distribution

Europe, Asia, Africa, and America.

Daucus carota Linn.

Fl. Brit. Ind., II, 718.

(Carrot)

Vernacular names: Afghanistan—Zardak; Arabic—Jazar; Bengal—Gajar; Gujerat—Gajar; Hindi—Gajar, Gajra; Kanarese—Gajjari, Kempu-mulangi; Kashmir—Bul-muj, Gazar, Kach, Mor-muj; Marathi—Gazara; Mundari—Gajara; Persian—Gazar, Zardak; Punjab—Gajar; Sanskrit—Garjara, Shikhamulam; Sind—Petaigagar; Tamil—Gajjara-kilangu, Karattu-kizhangu, Kartu-kilangu, Manjal-mullangi; Telugu—Gajjara, Pitakanda, Shikha-mulamu; Urdu—Gajar.

Botanical characters

Hispid biennial with tuberous root. Leaves 2–3-pinnate; pinnae pinnatifid, segments narrow-lanceolate. Outer rays connivent in fruit; bracteoles many. Fruit $\frac{1}{10}$ in.; bristles of the secondary ridges as broad as the fruit, glistening white, of primary shorter, subglochidiate, or 0; carpophore undivided.

Distribution

Cultivated throughout India as a vegetable.

Uses and properties

The carrot is universally used as an article of food by all classes of people, although some Hindus object to it on account of a fancied resemblance to beef or perhaps because of its smell. All parts of the

plant are used in indigenous medicine. Carrot seeds are considered to be stimulant, carminative, and diuretic, and are given in kidney diseases

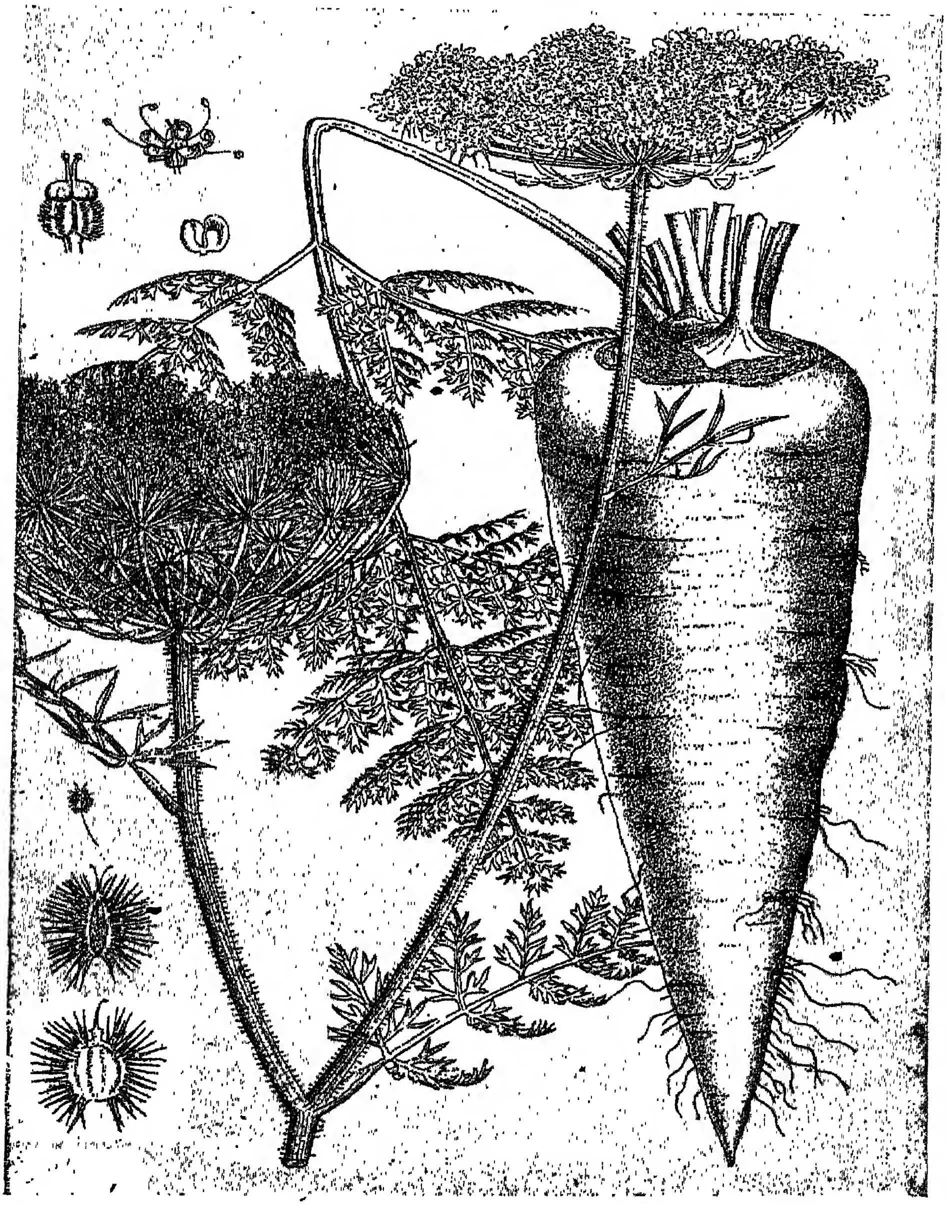

FIG. 112. *Daucus carota* Linn.

and dropsy; they have an aromatic odour and a pungent, warm, unpleasant taste. The seeds are also popularly regarded as a powerful abortifacient, and numerous cases of abortion, following their internal administration, are on record. More precise information is, however, needed in regard to their alleged abortifacient properties. It has been stated that some persons develop dermatitis on contact with carrot leaves, especially when they are wet.

Constituents

The fruit of the cultivated carrot yields 1 to 1·5 per cent of an essential oil containing l-α-pinene, and a crystalline body named daucol (*4*). The leaves contain the two bases pyrrolidine and daucine (*18*), besides an essential oil.

5. HYDROCOTYLE (Tourn.) Linn.

(From the Greek *hydor*—water, and *kotyle*—a cup; the plants thrive in moist places, and the roundish leaves have a cup-like depression in the middle.)

Botanical characters

Prostrate herbs, rooting at the nodes. Leaves cordate, orbicular or reniform, often palmately lobed, long-petioled; stipules scarious. Flowers white, small, in simple small axillary sessile or pedicellate umbels; involucral bracts small or 0. Calyx-teeth minute or 0. Petals entire, acute, valvate. Fruit laterally compressed; commissure obscure; mericarps with 3 primary but without secondary ridges; vittae 0; pericarp thin.

Distribution

In wet places in tropical and temperate regions.

Hydrocotyle javanica Thunb.

Fl. Brit. Ind., II, 667.

Botanical characters

Stem creeping, with erect flexuose branches. Leaves 1–3 in. diam., reniform, cordate, crenate and often 7–9-lobed, slightly hairy. Peduncle $\frac{1}{4}$–2 in.; lower solitary, leaf-opposed, upper often clustered. Umbels many-flowered; bracts minute, scattered among the pedicels. Flowers white. Fruit $\frac{1}{10}$ in., mericarps compressed; primary ridges obscure, secondary absent.

Distribution

Found from Kashmir to Bhutan at altitudes of 2,000 to 8,000 ft.; in the Khasia mountains between 2,000 to 6,000 ft.; and in the mountains of the Western Ghats and the Nilgiris and Pulneys, in shady places.

Uses and properties

This plant is used as a substitute for *Centella asiatica* (Linn.) Urban in Ceylon and the Malay Archipelago. It has been recorded as a fish poison by Pammel (*2*), but no such use is reported from India.

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Family XLIII.—ARALIACEAE

(Ivy and Ginseng Family)

Botanical characters

Trees or shrubs, sometimes climbing, rarely herbs, frequently prickly. Leaves usually alternate, long-petioled, simple or compound; stipules adnate to the petiole, sometimes within its sheathing base, or 0. Flowers small, bisexual or polygamous, in umbels, racemes or panicled heads, with bracts and bracteoles. Calyx-tube adnate to the ovary; limb truncate, obsolete or with small teeth. Petals 5, rarely 6–7 or many, valvate or subimbricate, separating or deciduous in a cap. Stamens as many as and alternate with the petals, rarely indefinite, inserted round an epigynous disc. Ovary inferior, 1–many-celled; styles as many as the cells, distinct or united; ovules solitary in each cell, pendulous. Fruit usually drupaceous or dry. Seeds albuminous.

Distribution

Chiefly tropical and subtropical; a few species in cool temperate regions.

Economic and toxic aspects

Many members of this family have a peculiar odour when crushed. Some plants, especially species of *Aralia* and *Panax*, are used in medicine as aromatic bitters. The most important of these are the roots of ginseng (*Panax quinquefolium* Linn. of America and *P. ginseng* C. A. Mey. of China), which are greatly valued by the Chinese and considered as a panacea for all diseases. Ginseng is largely cultivated in America and exported to China where it is considered stimulating, alterative, carminative, and tonic. Rice paper is obtained from the pith of *Fatsia papyrifera* Benth. & Hook. *f.* (*Tetrapanax papyriferum* C. Koch), a native of Formosa. Berries of ivy (*Hedera helix* Linn.) are stated to be poisonous to man.

In general the members of this family are aromatic and stimulant, and the fruits of some are bitter and astringent.

Constituents

The plants belonging to this family have been found to contain: (*a*) *saponins*, such as those found in the genera *Panax*, *Aralia*, *Fatsia*, *Polyscias*, *Heptapleurum*, *Trevesia*, etc., and (*b*) *glucosides*, such as α-hederin, araliin, etc.

HEDERA Tourn. *ex* Linn.

(The classical name for the ivy.)

Botanical characters

Climbing shrubs or small trees. Leaves simple, lobed or pinnate, glabrous, exstipulate. Flowers polygamous; umbels panicled; pedicels

not or very obscurely jointed under the flowers. Calyx-margin 5-toothed or subentire. Petals 5, valvate. Ovary 5-celled: styles connate. Fruit globose, almost berried. Seeds ovoid; albumen ruminated.

In temperate regions of the Old World. *Distribution*

Hedera helix Linn.*

Fl. Brit. Ind., II, 739.

(Bindwood, Ivy)

Vernacular names: Beas—Ban-batkari, Brumbrum-dakari; Chenab—Kurol; Hazara—Harbanbal; Jaunsar; Mithiari; Jhelum—Arbambal, Halbambar; Kashmir—Karmora, Mandia; Kulu—Kermi; Kumaon—Banda; Malayalam—Maravala; Nepal—Dudela; Pushtu—Parvata; Ravi—Karur, Kuri; Sutlej—Kadloli, Kaneri, Kaniuri, Karbaru; Tamil—Maravalai.

Botanical characters

An evergreen shrub climbing adhesively by means of adventitious rootlets over trees and rocks. Leaves variously lobed or pinnatifid or often quite entire. Flowers 1/5 in. across, yellowish-green, in subglobose umbels; peduncles and pedicels clothed with minute stellate scales. Berry 1/3 in. diam., yellow, rarely red (black in Europe).

Distribution

Ivy is found in the Himalayas from 2,000 to 10,000 ft. above sea level, and in the Khasia Hills from 4,000 to 6,000 ft.

Uses and properties

Ivy was at one time highly valued in medicine, but is now almost completely discarded. The leaves were used as a stimulant to sores. Ivy gum, which is a resinous exudate from the stems of old ivy plants, has been used in medicine as a stimulant and emmenagogue.

The berries have an acidulous, resinous, and somewhat pungent taste, and are said to have purgative and emetic properties. The fresh leaves have a balsamic odour and a harsh, bitterish, unpleasant taste. According to Watt and Breyer-Brandwijk (*1*), this fact apparently precludes livestock from eating it; although Stewart (*2*) says that it is stated to be a favourite food of goats. Watt (*3*) adds that the berries afford abundance of food for birds.

Wallis Hoare, quoted by Lander (*4*), mentions that the berries have long been known as poisonous, and cases of poisoning among children by them are on record. Besides emetic and purgative action, they are stated to be narcotic and produce symptoms of drunkenness involving

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* The Himalayan specimens of this plant differ from the European ones somewhat in the foliage, in the stellate hairs or scales on the inflorescence having more branches (15-18 against 6-7), and in the colour of the fruit. For this reason, Tobler ("Die Gattung Hedera, 1912") considers the Himalayan ivy as specifically distinct from the European, and calls it *H. himalaica*.

excitement at first, then coma and laboured respiration. Cases of poisoning in animals, however, are not on record; the leaves are eaten by cattle with impunity and are in fact given to sick cows. Pammel (*5*) also states that the plant has narcotic properties. According to Watt (*3*), a decoction of leaves is in some places said to be applied externally to destroy vermin in the heads of children. Some persons appear to be susceptible to ivy, since cases of dermatitis on contact with its leaves have been recorded.

FIG. 113. *Hedera helix* Linn.

Constituents

Nearly all parts of the plant, *viz.*, leaves, fruits, and seeds contain the glucoside α-hederin and probably certain other glucosides (*6*). According to work recently done, the leaves also contain a saponin which is closely related to α-hederin (*7*).

The glucoside hederin, isolated from the leaves, is intensely haemolytic, characterized by the "haemolytic paradox", *i.e.*, haemolysis is quicker and more complete with smaller than with higher concentrations. Hederin acts as an irritant to the alimentary canal; causes vasoconstriction; lowers the blood pressure; slows the heart and increases its tonus; and causes death by a paralysis of the respiration (*8*). For warm-blooded animals, 2–3 cgm per kgm of body weight are lethal. Cold-blooded animals appear to be less susceptible (*9*). *Action*

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Family XLIV.—CAPRIFOLIACEAE

(Honeysuckle Family)

Botanical characters

Shrubs, erect or scandent, or small trees, rarely herbs. Leaves opposite, rarely ternate, usually exstipulate. Flowers bisexual, cymose or paniculate, regular or irregular. Calyx-tube adnate to the ovary; lobes 3–5. Corolla gamopetalous, 5-lobed, often 2-lipped; lobes imbricate. Stamens usually 5, epipetalous. Ovary inferior, 2–8-, rarely 1-celled; ovules 1–many in each cell. Fruit a drupe with 1–8 cartilaginous pyrenes, or a many-seeded berry. Seeds albuminous.

Distribution

A small family mostly occurring in northern and temperate climes, also in mountains in the tropics.

Economic and toxic aspects

The members of this family are of little economic importance, but many are cultivated for ornamental purposes. Several plants belonging to the genus *Lonicera* are cultivated for the purpose of forming arbours and also as climbers on the walls of houses, etc., *e.g.*, honeysuckle or woodbine (*L. periclymenum* Linn.) and the trumpet honeysuckle (*L. sempervirens* Linn.). Some plants of the genus *Viburnum*, the guelder-roses, are also cultivated for ornamental purposes. The twigs of the foetid-smelling *V. foetidum* Wall. ('narwel') are suspended in the confinement rooms of Hindu women as a talisman against evil spirits and *post-partum* haemorrhage. It is an interesting coincidence to note that black haw (*V. prunifolium* Linn.) and guelder-rose (*V. opulus* Linn.), both foreign species, have a very wide reputation as uterine sedatives, although their usefulness in this respect has never been proved definitely. Fruits of some of the Himalayan guelder-roses, such as *V. foetens* Decne. and *V. nervosum* D. Don, are eaten by the people of the localities where they grow. The stems of some species of *Sambucus* contain a large white pith which is used for cleaning optical lenses and in microtomy for cutting sections.

European elder (*Sambucus nigra* Linn.) and dwarf elder (*S. ebulus* Linn.) are poisonous plants occurring in India; the former only in gardens. They have a foetid repulsive odour, and are not normally eaten by livestock. Cases of poisoning in children, cattle, and sheep due to the eating of American elder (*S. canadensis* Linn.) are also reported. Some of the species of *Lonicera* also are possibly poisonous. Pammel (*1*) records the presence of saponins in several members of this family, especially of the genus *Lonicera*.

In general, the barks of plants belonging to this family are astringent and purgative; leaves astringent; flowers mucilaginous, stimulant, and diaphoretic; and the fruits are laxative, emetic, and diaphoretic.

Constituents

The plants of this family have been found to contain: (*a*) *glucosides*, such as sambunigrin (cyanogenetic), rutin, fraxin, etc., (*b*) *saponins*, found in most of the genera, and (*c*) *acids*, such as formic, capric, valerianic, etc.

SAMBUCUS Tourn. *ex* Linn.

(Old Latin name for the elder tree.)

Botanical characters

Shrubs or small trees, rarely herbaceous. Leaves imparipinnate, often stipulate; leaflets serrate or laciniate. Corymbs large, very compound, bracteate; flowers small, jointed with the pedicel. Corolla rotate or campanulate, 3–5-partite. Ovary 3–5-celled; style short, 3–5-partite, or stigmas 3–5 sessile; ovules 1 in each cell, pendulous. Fruit baccate, with 3–5 stones.

Distribution

In temperate regions.

KEY TO THE SPECIES

a. A large erect herb	1. *S. ebulus*.
b. An erect shrub or a small tree	2. *S. nigra*.

1. Sambucus ebulus Linn.

Fl. Brit. Ind., III, 2.

(Danewort, Dwarf Elder, Walewort)

Vernacular names: CHENAB—Gandal, Gandala; PUNJAB—Gandal, Ganhula, Gwandish, Mushkiara, Richhkas, Siske, Tasar.

Botanical characters

An erect herb 3–6 ft. high. Leaves 6 12 in. long; stipules mostly foliaceous; leaflets 5–9, 3·8 in. long, oblong-lanceolate, sharply serrate. Flowers $\frac{1}{5}$ in. diam., white or yellowish, with a strong peculiar odour, in terminal corymbs 4–10 in. across. Fruit $\frac{1}{5}$ in. diam., red, turning black when ripe.

Distribution

A gregarious plant found in the dry inner valleys of the Himalayas, such as the Kagan valley, Kashmir, Pangi and Chamba, from 6,000 to 11,000 ft. above sea level.

Toxicity

This plant, when bruised, has a very disagreeable smell, resembling that of burnt flesh, and, in the authors' experience, is not browsed upon by any animal. It seems, therefore, very unlikely that spontaneous

poisoning will result from it. The roots and berries are actively purgative. Pammel (*1*) quotes cases in which 2 boys were poisoned, one eating freely of flowers and the other of leaves. The latter suffered from enteritis, the abdomen becoming so sore that it could scarcely be touched.

FIG. 114. *Sambucus ebulus* Linn.

The one who had eaten the flowers suffered considerably from vertigo with some headache, but the symptoms were not serious. Both these cases were nonfatal, but the boy who ate flowers could only be saved after vigorous treatment. It is also stated that the berries and flowers kill fowls, and that berries when freely eaten often produce giddiness.

Constituents

The leaves contain small quantities of a cyanogenetic glucoside (*2*) and 0·076 per cent of an essential oil (*3*). The bark from the roots and twigs contains a bitter substance, but no glucoside (*4*).

2. Sambucus nigra Linn.

(Elder)

Vernacular name : ARABIC—Uti-khaman.

Botanical characters

A deciduous shrub 15–20 ft. high or a small tree. Leaves 4–12 in. long ; leaflets 5 (3–7), $1\frac{1}{2}$–5 in. long, ovate, sharply toothed. Flowers yellowish or dull-white, with a heavy odour. Fruit shining, black.

Distribution

Indigenous to Europe and Asia Minor ; cultivated to a small extent in Indian gardens.

Uses and properties

A favourite beverage useful in colds, chills, etc., is prepared in the British Isles from the berries of this plant by boiling them with sugar ; it holds an important place in domestic pharmacy. The flowers are imported into India and are said to be stimulant and sudorific, and are sometimes pescribed as a laxative for children. In larger doses, they are said to produce nausea and diarrhoea.

Lander (*5*) states that all parts of the plant have a repulsive odour and animals do not eat it spontaneously. In the very rare cases of poisoning that have been recorded, the symptoms and lesions are those of superpurgation.

Constituents

The leaves contain a cyanogenetic glucoside, sambunigrin, which is an isomer of amygdonitrile glucoside, 100 gm of fresh leaves yielding 12 mgm of hydrocyanic acid. Hydrocyanic acid has also been found in nonglucosidal form in the young leaves. The glucoside on hydrolysis gives benzaldehyde, glucose, and hydrocyanic acid (*6, 7, 8*). As a rule, the amount of hydrocyanic acid is usually greatest in the young leaves and gradually diminishes as the leaves grow older ; the leaves which are about to fall off contain very little of the acid. *S. nigra*, according to Guignard, is one of the exceptions to this rule (*1*).

The flowers contain small quantities of a nitrile glucoside (*9*) ; they also contain about 0·025 per cent of an essential oil (*10*). The unripe berries contain a cyanogenetic glucoside, but this disappears in the ripe ones (*9*). The bark is said to contain a cathartic resin, a yellowish-red oil, and an alkaloid named sambucine (*11*). More recent work has shown that the bark, leaves, and flowers contain choline and an unidentified alkaloid (*12*).

Action

Sambunigrin resembles amygdalin in its action (*13*). It has also a diaphoretic and diuretic action (*14*). The active principles act uniquely on the intestines and stimulate the peristaltic movements without affecting the functions of the stomach and duodenum. They produce no pain, and the intestines do not become habituated to their use (*14*).

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Family XLV.—RUBIACEAE

(Madder and Coffee Family)

Botanical characters

Trees, shrubs or herbs, erect, prostrate or scandent, unarmed or thorny. Leaves opposite or whorled, simple, entire; stipules inter- or intra-petiolar, rarely 0. Flowers usually regular, rarely unisexual. Calyx-tube adnate to the ovary. Corolla gamopetalous, regular, usually 4–5-lobed. Stamens as many as the corolla-lobes, inserted on the mouth or tube of the corolla. Disc epigynous. Ovary inferior, 2-10-celled; ovules 1 or more in each cell; style simple or cleft. Fruit various. Seeds albuminous.

Distribution

A large family, mainly tropical and subtropical; quite a number of the species also occur in temperate regions, but very few in arctic regions.

Economic and toxic aspects

Several plants of this family are important from the economic point of view. Of these, species of *Cinchona* and *Coffea* (coffee) are of great importance and are largely cultivated in India. Cinchona is the source of the well-known drug quinine; and coffee is relished as a beverage all over the world. *Psychotria ipecacuanha* Stokes is another drug of repute which is used in the treatment of amoebic dysentery, and also as an emetic and expectorant. In general, the roots of the plants of this family are acrid, emetic, diaphoretic, purgative, and diuretic; the bark is generally bitter, astringent, tonic, and a febrifuge.

Some plants are grown in gardens, and among these may be mentioned: *Hamelia patens* Jacq., a large evergreen shrub with scarlet flowers; *Anthocephalus cadamba* (Roxb.) Miq., a large evergreen tree with orange flowers; *Mussaenda frondosa* Linn., with one calyx-lobe much enlarged like a white or yellow leaf; species of *Ixora*, with handsome bunches of flowers, etc.

Morinda citrifolia Linn. (Indian mulberry) was at one time largely cultivated in India for the sake of 'ál' dye obtained from the root, root-bark, and wood of the plant. The roots of this plant are also cathartic. The roots of *Rubia cordifolia* Linn. (Indian madder) are used for medicinal purposes; they were once widely used as a dye in India. Indeed, there are several other plants of this family which are used in indigenous medicine in this country. An extract made from the leaves of *Uncaria gambir* (Hunter) Roxb. (gambier, yellow catechu) is used for tanning leather, and is largely employed in India as an ingredient of the chewing 'pan' (betel leaf).

The leaves and roots of 'gandha-bhadulia' (*Paederia foetida* Linn.), an extensive climber, are considered to possess medicinal properties; the latter are used as an emetic. The leaves have a faecal odour, are bitter in taste, but are used in Bengal as a constituent of stews and curries prepared for convalescents, especially those recovering from bowel complaints. They contain a highly offensive volatile oil and are stated to contain alkaloids. Fruits of *Gardenia campanulata* Roxb. of Bengal, Assam, and Bihar are used as a cathartic and anthelmintic.

Randia dumetorum Lam. (common emetic nut) and *R. uliginosa* DC. (grey emetic nut) are used as fish poisons, and also for medicinal purposes. The juice of *Adina cordifolia* (Roxb.) Benth. & Hook. *f.* is used as an insecticide. *Pachystigma pygmaea* (Schlecht.) Robyns (*Vangueria pygmaea* Schlecht.) is the cause of heavy mortality in sheep in South Africa. The disease produced by it is called "gousiekte"; it is characterized by cardiac affections which may result in sudden heart failure.

Constituents The chemical constituents found among the members of this family are: (*a*) *Cinchona alkaloids*, such as quinine, quinidine, cinchonine, cinchonidine, hydroquinine, hydroquinidine, cinchotine, quinamine, aricine, cusconine, etc.; *remijia alkaloids*, such as cinchonamine, concusconine, etc.; *yohimbé alkaloids*, such as yohimbine (quebrachine), corynantheine, etc.; *ipecacuanha alkaloids*, such as emetine, cephaeline, psychotrine, emetamine, etc.; other *alkaloids*, such as caffeine, aribine (harman), mitragynine, mitraversine, mitraphylline, rubradinine, etc., (*b*) *saponins*, such as those found in the genera *Randia*, *Mussaenda*, *Chiococca*, etc., (*c*) *glucosides*, such as hesperidin, asperuloside, danain, cephalanthin, chinovin, calmatambin, etc., (*d*) *bitter substances*, such as those found in the genera *Pinckneya*, *Hymenodictyon*, *Sarcocephalus*, etc., (*e*) *essential oils* having constituents like benzyl acetate, o-hydroxy acetophenone, valeric acid, furfuryl alcohol, etc., and (*f*) *acids*, such as chlorogenic, quinic, caffeic, butyric, formic, etc.

KEY TO THE GENERA

A. Ovules numerous in each cell.
- I. Flowers collected in dense globose heads, bracteolate. Calyx-limb 5-lobed. Corolla-lobes valvate .. .. 1. *Adina*.
- II. Flowers not collected in dense globose heads.
  - *a*. Corolla-lobes valvate, with pilose margins. Fruit a 2-valved capsule. Seeds winged .. .. 2. *Cinchona*.
  - *b*. Corolla-lobes twisted in bud. Fruit berried. Seeds angled .. .. 5. *Randia*.

B. Ovules solitary in each cell.
- I. Flowers in axillary fascicles or cymes or solitary. Corolla-lobes twisted in bud. Ovules peltate on the septum .. .. 3. *Coffea*.
- II. Flowers in terminal cymes, heads or fascicles. Corolla-lobes valvate in bud. Ovules basal .. .. .. 4. *Psychotria*.

1. ADINA Salisb.

(From the Greek *adinos*—crowded ; referring to the flowers being disposed in heads.)

Botanical characters

Trees or shrubs. Stipules large, caducous. Flowers small, crowded in solitary or panicled globose heads, the receptacle with stiff hairs ; bracts in pairs on the peduncle or 0 ; bracteoles paleaceous. Calyx-tube angled ; lobes 5. Corolla funnel-shaped or tubular ; lobes 5, valvate. Stamens 5, on the throat of the corolla; filaments short. Ovary 2-celled ; style filiform ; stigma clavate, rarely capitate ; ovules numerous in each cell. Capsule of 2 dehiscent cocci, many-seeded. Seeds oblong, winged, albuminous.

Distribution

Tropical and subtropical Asia and America.

Adina cordifolia (Roxb.) Benth. & Hook. *f.*

Fl. Brit. Ind., III, 24.

Vernacular names : ASSAM—Keli-kadam, Roghu ; BAHRAICH—Tikkoe ; BENGAL—Bangka, Dako, Dakom, Kali-kadam, Keli-kadamba, Petpuria ; BURMA—Hnau-beng, Hnau, Nhan-ben, Nhing-pen ; CENTRAL PROVINCES—Haldi, Hardu, Hardua ; GARO—Shangdong ; GOND—Hardu, Kurmi, Paspu ; GONDA—Tikkoe ; GUJERATI—Aldavan, Haladaravo, Haladhvan ; HINDI—Haladu, Haldava, Haldu, Haludava, Harda, Hardu, Kadami, Karam, Ladiva ; KANARESE—Ahnau, Anavu, Anigallu, Arsanatega, Arsinatege, Arunsantige, Dodda-kadaga, Hedde, Heretege, Hettiga, Kadaga, Kadambe, Pachenike, Pettige, Yettaga, Yettagal, Yettega-pettega, Yuethagada ; KHOND—Mandugram ; KOLAMI—Komba-sanko, Kumba, Kurumba ; KONKANI—Edu ; KUMAON—Haldu ; MALAYALAM—Bara-kuram, Katampa, Hanja-kadambu, Manna-katampa, Pitampu ; MARATHI—Haldarava, Haldiva, Hed, Hedi, Hedu, Honangi ; MYSORE—Arsintega; NEPAL—Karam ; OUDH—Tikhoe ; PORTUGUESE INDIA—Aldavana ; SANSKRIT—Dharakadamba ; SANTAL—Karam ; TAMIL—Kadambai-maram, Manja-kadambe ; TELUGU—Bandaru, Betta-ganapa, Daduga, Dudagu, Kamada, Kamba, Pacha-botruga, Pacha-ganapa, Paspu-kadimi, Paspu-kandi, Pasupu-kadimi, Rudra-ganapa, Rudra-kadapa ; TULU—Anavu ; URIYA—Halanda, Holondo, Keli-kodombo.

Botanical characters

A large deciduous tree. Leaves petioled, 4–12 in. diam., orbicular-cordate, abruptly acuminate, pubescent beneath. Peduncles axillary, 1–3 together, 1-headed, with 2 small bracts near the apex. Heads globose, $\frac{3}{4}$–1 in. diam. Flowers yellow ; corolla downy ; stigma clavate. Capsule $\frac{1}{6}$ in., cuneate, downy ; cells about 6-seeded.

Distribution

Found in the Sub-Himalayan tract from the Jumna eastwards, ascending to an altitude of 3,000 ft. and extending throughout the moister regions of India. (It is common in Western India, especially in the forests of Ratnagiri and Thana Districts of Konkan, and in the forests of Surat and Baroda ; from thence it extends southwards into the forests of Mysore, and is plentiful in the forests of Upper Godaveri and Bhandara in Central Provinces.)

Uses and properties

The small buds, ground with round pepper, are used as a snuff to relieve headache, and the roots are used as a medicine in Assam. It is

also believed to have febrifugal and antiseptic properties. The juice is used to kill maggots in sores.

Constituents

A bitter principle has been isolated from this plant (*1*).

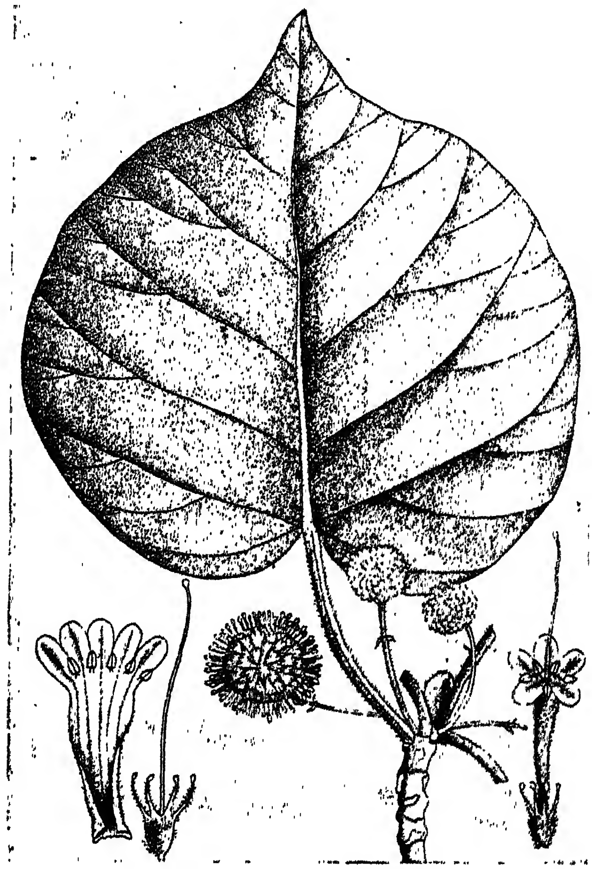

FIG. 115. *Adina cordifolia* (Roxb.) Benth. & Hook. *f.*

2. CINCHONA Linn.

(After the wife of Count *Chinchon*, Viceroy of Peru in the seventeenth century, who was cured of an intermittent fever by its use.)

Botanical characters

Evergreen shrubs or trees; bark bitter; stipules deciduous. Flowers pentamerous, scented, in terminal panicles. Calyx pubescent; limb 5-dentate, persistent. Corolla tubular, pubescent outside; lobes valvate in bud, edge fringed with soft hairs. Ovary 2-celled; style slender with 2 short obtuse branches, papillose inside. Capsule 2-celled, 2-valved,

dehiscing septicidally from the base. Seeds numerous, peltate, the broad wings with irregularly lacerated edge.

Origin and distribution

Species of *Cinchona* grow isolated or in small clumps in the dense forests on the eastern slopes of the central western chain of the Andes in South America. They flourish at altitudes from 3,000 to 10,000 ft. from Costa Rica to the southern borders of Bolivia. The trees may reach 80 ft. in height and are valued for their bark which contains certain potent alkaloids. Cinchona bark is said to have been introduced into Europe about the year 1639 A.D. by the Countess of Chinchon. Through the efforts of Sir Clement R. Markham cinchona trees were successfully planted in 1860 on the Nilgiri Hills in Southern India, and, as they grew well there, plantations were also started in Mungpoo in the Ranghi Valley, Bengal, and also in the Karen Hills of Burma in 1864. There are between 30 and 40 species of *Cinchona* with numerous hybrids and varieties. Indeed, so readily do these species hybridize that some doubt may be entertained as to the desirability of retaining as species many forms that have been described as such. The commercial barks are obtained from about half a dozen species.

The chief cinchonas which are cultivated in India are : *C. calisaya* Wedd. (calisaya bark or yellow bark of commerce), *C. calisaya* Wedd., var. *ledgeriana* Howard (ledger bark or ledger hybrid bark), *C. officinalis* Linn. (loxa or crown bark, pale bark of commerce), and *C. succirubra* Pav. *ex* Klotzsch (red bark). These and some of their hybrids are the important cinchonas grown in India for local demand, and the yield of the bark from these sources has been kept up at as high a level as possible in spite of many difficulties. A few other species have also been tried in India.

Bark and quinine

There is a large demand all over the world for cinchona bark and its alkaloids for use in the treatment of malaria.

The annual consumption of quinine in India at present is nearly 200,000 lbs of which about 70,000 lbs are manufactured in India and the rest imported (*1*).

The total production of quinine is about 600,000 kgm per annum, but it is doubtful whether this amount is sufficient for the needs of the whole world (*2*).

Constituents

A number of alkaloids have been obtained from the bark of the cinchonas, their amount differing in the numerous species and hybrids, and indeed in individual places and in different parts of the same plant. The alkaloids resemble each other in their chemical and pharmacological properties. The best known of these are quinine, quinidine, cinchonine, and cinchonidine ; the others, about twenty in number (*see* appendix),

are believed to have a similar action on the organism as the above four alkaloids. The alkaloids are present in very small quantities only in the leaves, but larger quantities are found in the stem-bark increasing from above downwards as the root is approached. The alkaloids exist in the bark in combination with cinchotannic acid, quinic acid or other organic acids. Besides these alkaloids, cinchona bark contains a few free organic acids, tannins, some neutral substances, colouring matters, and traces of volatile oil, gum, starch and other vegetable matter. The ash, 1 to 2 per cent, consists mainly of calcium and potassium carbonates, and a little silica.

Action of cinchona alkaloids

The type of action produced by quinine closely resembles that produced by other alkaloids and it can be taken as a typical example of this group. Quinine is a general protoplasmic poison which in sufficient concentration is fatal to almost all live cells, including those in which only purely vegetative processes take place. In mammals, it has a depressant action on the heart and the central nervous system. Its action on the striated muscle is depressant. Unstriated muscle in the mammals tends to contract under the influence of quinine, the action being specially marked on the uterus which is thrown into rhythmical contractions. Abortion occurs occasionally after its use in malaria, while in other cases labour pains may be induced. Quinine has no significant effect on the normal temperature in man or animals. In most febrile conditions, however, average nontoxic doses produce a fall of temperature. Given internally quinine is a bitter stomachic, useful in atonic dyspepsia and as a tonic in convalescence and debility. It is used as a sedative and antipyretic in fevers, and is also useful in neuralgia, catarrh, and hay fever. Pessaries containing 3 grains of the hydrochloride in the oil of theobroma basis are used as contraceptives.

Until recent years the crystallizable alkaloids quinine, quinidine, cinchonine, and cinchonidine were the only drugs available which had specific action on malarial parasites. If given in suitable doses and under proper conditions, their action in controlling malarial paroxysms is certain. Of the four alkaloids, quinine still holds the foremost position in the treatment of malaria, although the antimalarial value of the other three alkaloids has also been fully established. From data now available there is no room for doubt that quinidine, cinchonine, and cinchonidine, in similar doses to quinine, are equally or very nearly as effective in the treatment of malaria. In considering the relative therapeutic value of different alkaloids, it is of importance to take into account their effect in causing harm or inconvenience to the patient. It may be said in favour of quinine that it can as a rule be given in sufficient doses and for sufficiently long periods without danger to the patient. Cinchonine is

more nauseating than quinine and is liable to produce blurring of vision. Quinidine is also more nauseating and has a powerful depressant action on the heart. Cinchonidine is neither toxic nor irritant, but is distinctly the weakest of the four alkaloids.

The importance of the fact that all these alkaloids have marked anti-malarial properties is very great to India where the economic condition of the people is low and purified quinine preparations, on account of their high price, are beyond the means of ordinary people. It should follow, therefore, that if the total alkaloids are used they will be cheaper than if only quinine were used by itself. It is for this reason that " cinchona febrifuge " has been used in India and the League of Nations have introduced " totaquina ", which contains 70 per cent of the total alkaloids of which 15 per cent must be quinine. By this means it is hoped that the treatment could be made less expensive and extended among the masses of the people.

Toxic effects of cinchona alkaloids

Quinine is one of the least toxic of the alkaloids, the lethal dose by mouth in animals being 1·0 gm per kgm of body weight. The fatal dose in man is 8 to 15 gm by mouth, but in a few instances as much as 30 gm has been taken without producing death. Two to three gm can be tolerated, but 5 gm always produces toxic effects. The toxic effects vary enormously in different individuals (*2*).

The toxic effects produced by quinine are discussed under the following headings :—

Quinine idiosyncrasy

Some individuals show very peculiar susceptibilities or sensitiveness, even when such minute quantities as $\frac{1}{10}$ grain are given. The symptoms which manifest themselves are a variety of skin eruptions, such as scarlatina-like erythema, urticarial rashes, intolerable itching or bulbous eruptions, which may be accompanied by fever. Other symptoms are dyspnoea, fever, nausea, and vomiting ; sometimes there are giddiness and fainting. There may be extravasation of blood in the skin and perhaps in the intestines and kidneys ; occasionally there is severe prostration, which disappears on the following day. Sometimes cinchonine or quinidine does not produce idiosyncrasy in cases where quinine does so. Rarely, quinine produces a paradoxical or contrary action, producing an enormous rise of temperature accompanied by rigors instead of the expected fall. This phenomenon still remains unexplained.

Desensitization

Desensitization has been proposed and tried successfully in some cases. The patient is given by mouth 5 mgm of quinine bisulphate plus 0·5 gm of sodium bicarbonate to start with. After 1½ hour, 0·5 gm of sodium bicarbonate and 0·1 gm of quinine are given. The two doses of quinine are repeated daily, the desensitizing dose being left at 5 mgm and

the second dose being increased by 0·1 gm every day. Another plan is to give 0·5 to 1·0 c.cm of adrenalin by injection, followed 20 minutes later by a small dose of quinine, such as 0·05 gm. Next day the same injection of adrenalin is given, but the dose of quinine is increased.

Cinchonism

Cinchonism is the name given to the early symptoms, chiefly connected with the central nervous system, which appear when quinine or other cinchona alkaloids are given in large doses. This should be differentiated from idiosyncrasy, which is a condition of increased susceptibility and which is brought about by very small doses. Some individuals are, however, very much more liable to get cinchonism than others. Cinchonine is most powerful in producing cinchonism ; next comes quinine then quinidine, and lastly cinchonidine. The early symptoms are nausea, vomiting, headache (due to cerebral congestion), ringing in the ears, giddiness and disturbed vision (due to selective changes in the vessels of the eye and ear).

When a toxic dose of quinine is taken, the first symptom is usually severe bursting headache, accompanied by low roaring noises in the ears and deafness which may be complete, but is rarely permanent. There is loss of taste and smell, mental depression, photophobia and later blindness, at first partial and then complete. With very large doses, abdominal pains with nausea, diarrhoea, vomiting and general muscular weakness occur followed by a difficulty in speech, confusion of ideas, somnolence, loss of conciousness, delirium, general paralysis, coma, at times convulsions and finally death from collapse. Chills and cold sweats are also common, the pulse is rapid and weak, and the respiration shallow. Large doses paralyze first the brain and the respiratory centre and later the heart. The medullary centres are, as a rule, not affected till very late, and patients may recover even after very large doses. Quinine amblyopia and amaurosis have also been described. Quinine also produces skin rashes. There may be erythema, urticarial weals, swelling of the tongue and face, oedema of the eyelids, a scaly condition of the skin, and a generalized itching eruption. It may also cause haemorrhage from nose, uterus, and kidneys (*2*).

Quinine albuminuria

When large quantities of quinine are excreted by the kidneys as such, a temporary albuminuria may be produced.

Visceral degeneration

Cornwall (1920) observed, after large doses of quinine in rabbits, degenerative changes in the suprarenals and the kidneys and increased degenerations of the erythrocytes in the spleen. That quinine has toxic effects on the liver has been experimentally proved. Quinine has a certain amount of haemolytic effect on the blood cells, especially in high concentrations (*2*).

Treatment of cinchonism

Numerous drugs have been tried to obviate cinchonism, and of these caffeine given subcutaneously or intravenously shortly before the administration of quinine is the best. To relieve headache, phenacetin has been tried but it may depress the heart. If nausea be present, 20 to 30 grains of sodium bicarbonate in a tumblerful of hot water is useful. Bromide of quinine is said to produce fewer symptoms of cinchonism, and, therefore, quinine has often been prescribed with hydrobromic acid (*2*).

Other alkaloids

The toxic effects of the other cinchona alkaloids are similar to those produced by quinine, but they show important differences. Cinchonine and cinchonidine, in large doses, produce tonic and clonic convulsions, the site of their action on the brain being located below the optic thalami. Quinidine has a stronger depressant and paralyzing effect on the heart. Cupreine is about half as toxic as quinine. Cinchonine is more toxic than quinine and produces salivation, hallucinations, and epileptiform convulsions. It has little effect on the blood pressure.

The grave effects of cinchonism are only met with when the dose of quinine is increased beyond 40 to 60 grains a day. A form of toxaemia occurs in patients taking large doses of quinine for prolonged periods.

The toxic effects of quinine have been attributed by some to the formation of a body called quinotoxin, which is produced by the action of free organic acids on quinine, and it has been suggested that such conditions arise in the gut. It may, however, be noted that this substance has a very low toxicity and could not be responsible for these effects (*2*).

Fish poison

Pammel (*3*) mentions *Cinchona* species as fish poisons.

Quinine requirements of India

Sources of Supply of Quinine in India.—The annual consumption of quinine in India at present is nearly 200,000 lbs derived from two sources :—

(*a*) There are in India two State-owned cinchona plantations with factories for the production of quinine. One of the plantations is situated at Mungpoo, in the Darjeeling District in Bengal, and the other at Neduvattam, near Ootacamund in the Nilgiris. There were a number of privately owned plantations in the Nilgiris, but during recent years these have dwindled to almost nothing. According to Calder, late Superintendent, Cinchona Cultivation in Bengal, private Indian-grown bark, once fairly plentiful, may now be said to be a rarity on the market. When it does appear, it is sold only at prices much below the prevailing rates because of its inferior quality.

(*b*) As the combined production of quinine by the two factories does not exceed 70,000 lbs annually, large quantities of this drug have to be imported from Java. The following table shows the amount of

quinine derived from the two sources, *i.e.*, manufactured in India and imported into India in lbs :—

Year	Mungpoo	Madras	Imported	Total
1927-28 .	(46,844	21,688)	113,637	182,169
	68,532			
1928-29 .	(41,368	23,065)	133,795	198,228
	64,433			
1929-30 .	44,140	..	..	..

Indian Requirements.—That quinine is one of the most needed drugs from the point of view of the Indian public is obvious from the fact that it is used both in the prophylaxis and treatment of malaria, which is the most widespread disease in the country. The high incidence of this malady is a sufficient ground for a demand for an adequate supply of this valuable drug. It has been estimated that there are in India 100,000,000 untreated sufferers from malaria and a little over 8,000,000 receiving complete or partial treatment. These figures, though not necessarily accurate, are, however, sufficient to show to what an extent the population suffers from this disease. In addition to the high mortality there is the induced state of incapacity of individuals, both temporary and permanent. The economic loss, and the consequent penalty which has to be paid by the country as a whole, is enormous. Figures have not been worked out for India, but, according to Andrew Balfour's estimation, the direct loss sustained by the British Empire due to sickness and death caused by malaria amounts to between £52,000,000 and £62,000,000 annually. The share of India might easily be over a half of these amounts.

In view of these facts it is of interest to see what is the annual consumption per head of quinine in India, as compared with other countries in which a high incidence of malaria occurs. In Italy the consumption is 16 grains per head, in Greece 24 grains, whereas in India it is only 3½ grains. The figures for some of the highly malarious provinces in India show an even lower rate of consumption. For instance, in the different divisions of the Bengal Presidency, which is perhaps the most heavily infected area, the consumption per head in Burdwan is 1·07 grains, the Presidency Division 1·31 grains, Rajshahi 1·07 grains, Dacca 1·50 grains, and in Chittagong 2·6 grains. These figures speak for themselves and show how inadequate is the supply of quinine in India.

The next question which arises is, " What is the quantity of quinine actually required from the point of view of public health in India ?"

It has been stated that if each case is treated with 110 grains of quinine, which may be taken as a minimum for the cure of each paroxysm, the demand for hospital and dispensary treatment alone would be 125,000 lbs a year. Patients do not get as much as they ought to, because the cost of quinine is prohibitive. It is estimated that there are 100,000,000 sufferers from malaria who do not attend the hospitals. The potential demand is, therefore, somewhere between 125,000 lbs and 1,500,000 lbs. When in 1903 the Italian Government made quinine a State industry and cheapened its retail price, consumption in that country increased enormously and malaria mortality was reduced from 15,000 to 3,000 a year.

The Public Health Commissioner with the Government of India in a recent report stated : " It may be said that there is no question of the effective treatment of malaria in India until the consumption of quinine approximates to 500,000 lbs." Sir Patrick Hehir estimated that for India 970,000 lbs of quinine would be the minimum amount required to deal properly with the malaria problem. The Royal Commission on Agriculture was also of the opinion that both for the prevention and the treatment of malaria a much wider distribution of quinine is necessary (para 411). According to Bentley, at one time Director of Public Health in Bengal, 100,000 lbs of quinine must be consumed annually in that province alone before any appreciable effect will be possible (*1*).

The estimated figures for the requirements of the country adduced from different sources may vary considerably, but all alike demonstrate the hopeless insufficiency of the present supplies of quinine.

KEY TO THE SPECIES

a. Leaves glabrous, shining above, obtuse, oblong-lanceolate or oblong-obovate .. .. 1. *C. calisaya*.

b. Leaves glabrous, lanceolate or ovate-lanceolate, acute or shortly acuminate .. .. 2. *C. officinalis*.

c. Leaves soft, pubescent or tomentose and often red beneath, elliptic, acute at both ends .. .. 3. *C. succirubra*.

1. Cinchona calisaya Wedd.

(Bolivian Bark, Calisaya Bark, Yellow Bark)

Vernacular names : DECCAN—Burak ; TAMIL—Shura-pattai ; TELUGU—Frada-patta.

Botanical characters

Leaves glabrous, shining above, obtuse, oblong-lanceolate or oblong-obovate, blade 3–6 in. long, petiole $\frac{1}{2}$–$\frac{5}{8}$ in. long, axillary pits indistinct. Flowers pale flesh-coloured, cymes few-flowered, in a terminal pyramidal panicle, the lower branches in the axils of leaves. Corolla $\frac{1}{3}$–$\frac{2}{3}$ in. long ;

lobes lanceolate, rose-coloured, fringed with pure white hairs. Capsule ovoid-oblong, $\frac{1}{3}$–$\frac{2}{3}$ in. long.

Distribution

A native of Bolivia and Peru; a very variable tree, with the trunk twice as thick as a man's body, when well grown. This species has succeeded well under Indian climatic conditions, and is largely cultivated in Sikkim at elevations of 1,500 to 3,000 ft. above sea level. Numerous varieties and hybrids of this species have been distinguished. The best known is the var. *ledgeriana* Howard which by many writers is considered to be only a form of *C. calisaya*. In cultivation it has many peculiarities that entitle it to a separate position, at least commercially.

Variety ledgeriana

CINCHONA CALISAYA Wedd., var. LEDGERIANA Howard

(Ledger Bark, Ledger Hybrid Bark)

Botanical characters

Leaves glabrous, lanceolate or elliptic-oblong, acute, blade 3–5 in. long, petiole $\frac{1}{4}$–$\frac{3}{4}$ in. long, those of coppice shoots much longer. Flowers strongly scented, yellowish-white; pedicles $\frac{1}{6}$ in. long. Corolla $\frac{1}{3}$–$\frac{1}{2}$ in. long, tube pentagonous; lobes of the same colour as the tube, fringed with very long white hairs. Capsule ovoid-lanceolate, $\frac{1}{3}$–$\frac{1}{2}$ in. long, on pedicels $\frac{1}{4}$–$\frac{1}{3}$ in. long.

Distribution

A native of Bolivia. The cultivation of this variety is now being developed in all the Indian plantations and is gradually replacing *C. succirubra* Pav. *ex* Klotzsch. It is largely grown in Java, and, of all the cultivated species, yields the most plentiful supply of quinine.

Constituents

The alkaloidal content of the different parts of the Indian variety has been found by Shaw to be as follows (*1*):—

—	Total Alkaloids	Quinine	Cinchonidine	Quinidine	Cinchonine	Amorphous alkaloids
Root-bark ..	7·47	5·11	0·44	0·53	0·68	0·71
Stem-bark ..	5·79	4·14	0·36	0·44	0·25	0·60
Branch-bark ..	2·98	1·98	0·09	0·14	0·20	0·57

The leaves contain very little of the alkaloids (*4*), and the seeds only 0·38 per cent (*5*).

2. Cinchona officinalis Linn.

(Crown Bark, Loxa Bark, Pale Bark of Commerce)

Botanical characters

Leaves 3–6 in., glabrous, lanceolate or ovate-lanceolate, acute or shortly acuminate, petiole 1–1$\frac{1}{2}$ in. long, secondary nerves 8–10 pairs,

hairy pits in their axils. Flowers red, in short corymbiform compound cymes, terminal and axillary; corolla-tube $\frac{1}{2}$–$\frac{2}{3}$ in. long, densely silky with white appressed hairs, slightly pentagonal. Capsules $\frac{2}{3}$–$\frac{4}{5}$ in. long, ovoid-oblong.

Distribution

This species, with several varieties, is a native of Peru and Ecuador, found at elevations of 6,000 to 7,000 ft. above sea level. It is cultivated in South India in the Nilgiris near Ootacamund, and thrives at higher altitudes (between 6,000 to 8,500 ft.) better than any other species. The cultivation of this species has been practically abandoned in Sikkim, as the climate was found to be too moist.

Constituents

The alkaloidal content of the different parts of the Indian plants, according to Shaw, is as follows (*1*) :—

——	Total Alkaloids	Quinine	Cinchonidine	Quinidine	Cinchonine	Amorphous alkaloids
Root-bark ..	4·16	1·76	0·49	0·52	0·66	0·63
Stem-bark ..	4·42	2·56	0·89	0·13	0·37	0·47
Branch-bark ..	2·35	1·44	0·49	0·09	0·19	0·14

3. Cinchona succirubra Pav. *ex* Klotzsch

(Red Bark)

Botanical characters

A large tree attaining 80 ft. in height, usually smaller. Leaves soft, pubescent or tomentose, often red beneath, elliptic, acute at both ends, blade 6–12 in., petiole 1–1$\frac{1}{2}$ in. long, no pits in the axils of secondary nerves. Cymes compact in large pyramidal thyrsus. Flowers rose-coloured ; corolla $\frac{1}{2}$–$\frac{4}{5}$ in. long. Capsule 1–1$\frac{1}{4}$ in. long, oblong, narrowed towards the apex.

Distribution

This plant is a native of Ecuador and is largely cultivated in South India at altitudes of 4,500 to 6,000 ft. It is also grown in the Government of Bengal Plantations at Mungpoo (Sikkim), and in parts of the Satpura Range in Central India. It has proved to be the hardiest and most easily cultivated species, and succeeds well at altitudes of 3,000 to 6,000 ft.

Constituents

This species yields the best bark when eight years old, and from it cinchona febrifuge is chiefly prepared. The dried bark contains, in addition to the alkaloids, a brick-red colouring matter which is not found in the growing plant.

FIG. 116. *Cinchona succirubra* Pav. *ex* Klotzsch

The proportions of the important alkaloids in the bark of an Indian sample examined by Shaw were as follows (*1*) :—

——	Total alkaloids	Quinine	Cinchonidine	Quinidine	Cinchonine	Amorphous alkaloids
Root-bark ..	7·21	1·42	1·12	0·37	3·00	1·30
Stem-bark ..	6·09	1·74	1·47	0·20	1·63	1·05
Branch-bark ..	4·00	1·16	0·82	0·20	1·10	0·72

3. COFFEA Linn.

(From the Arabian name for the drink, itself conjecturally derived from *Caffa*, a district in Southern Abyssinia.)

Botanical characters

Shrubs; branchlets compressed. Leaves opposite, rarely in threes; stipules broad, interpetiolar. Flowers in axillary fascicles or cymes or solitary, white or yellowish, often scented; bracteoles often connate. Calyx-tube short; limb short, often glandular, persistent. Corolla-lobes 4–7, spreading, twisted in bud. Anthers 4–7, sessile, often recurved or twisted. Ovary 2-celled; style slender, bifid at apex; ovules solitary in each cell, peltate on the septum. Drupe with 2 plano-convex or ventrally concave cartilaginous or bony pyrenes. Seeds concave or grooved ventrally; testa membranous; albumen horny; radicle inferior.

Distribution

In the tropical climes of the Old World.

Coffea arabica Linn.

Fl. Brit. Ind., III, 153, without description.

(Arabian Coffee, Coffee Plant)

Vernacular names: ARABIC—Bun, Qahva, Quohva; BENGAL—Kafi, Kapi, Kava; BURMA—Kaphi-si, Ka-pwot; GUJERAT—Bund, Kappi; HINDI—Bun, Kava, Koffi; KANARESE—Bonda, Kapi; MALAYALAM—Kappikura, Kava, Kopi; MARATHI—Bun, Bund, Kan, Kaphi; PERSIAN—Bun, Qahva, Tukhme-qovah; TAMIL—Kapi; TELUGU—Kapi.

Botanical characters

A glabrous evergreen shrub or a small tree. Leaves 4–8 in. long, shining, oblong or elliptic-oblong, shortly acuminate. Flowers white, 1–3-nate or in condensed 1–2-nate axillary cymes, appearing with leaves. Corolla-tube $\frac{1}{3}$–$\frac{1}{2}$ in. long; lobes 5, $\frac{2}{5}$–$\frac{3}{5}$ in. long. Drupe oblong with 2 pyrenes (the well-known coffee beans).

Coffee resources of India

Coffee is grown principally in Madras, Coorg, Mysore, Travancore, and Cochin where the enterprise has been very successful.

The number of reporting plantations in the year 1936-37 was 6 911 covering a total area of 337,687 acres, as against 6,823 plantations with

an area of 335,115 acres in 1935-36. Of the total area under coffee during 1936-37, Mysore accounted for 55 per cent, Madras 23 per cent, Coorg 21 per cent, and Orissa, Travancore and Cochin 1 per cent. The total reported production of cured coffee during 1936-37 was 34,007,889 lbs, as compared with 41,172,670 lbs in the preceding year.

FIG. 117. *Coffea arabica* Linn.

India at present supplies not only the coffee consumed in the country, but exports large quantities abroad. In addition to *C. arabica* there are a few other species, such as *C. liberica* Hiern (the Liberian coffee), which are also cultivated in this country. The total export of Indian coffee increased from 173,000 cwts in 1932-33 to 186,000 cwts in 1933-34, but declined to 141,000 cwts in 1934-35 and again advanced to 216,000 cwts in 1935-36. In 1936-37, however, the exports again declined to 211,000 cwts.

History

Coffee, which is obtained by roasting and grinding the seeds, is an important article of popular consumption. Its use originated in Arabia and Egypt about the middle of the fifteenth century. Coffee and tea were introduced into Europe about the last quarter of the seventeenth century, about the same time as the potato, cinchona, tobacco, and chocolate.

Most authors agree that coffee plant is indigenous to Abyssinia and the Sudan. The history of its introduction into India is obscure. Tradition, however, says that a Mohammedan pilgrim named Baba Budan brought seven seeds with him some two and a half centuries ago on his return from Mecca to Mysore, and started the cultivation of this plant.

Constituents

The constituents of the seeds (raw beans) are caffeine, fat, caffealic and chlorogenic acids, saccharose, etc. The percentage of caffeine varies in different specimens from 0·72 to 2·43 per cent, usually about 1·25 per cent. It exists mainly as caffeine-potassium chlorogenate (*3*, *7*). The seeds also contain trigonelline (*8*).

Besides caffeine, the leaves and the fruits contain vernine, adenine, xanthine, hypoxanthine, and guanine (*9*). Flowers contain 0·90 per cent of caffeine (*10*).

In the process of roasting (*i.e.*, heating the seed to 200° to 250°C) a small amount of caffeine is volatilized, but, since about 10 per cent of water is given off, the percentage is actually a trifle higher (1·25 per cent). The main change in roasting consists in the production of aromatic, brown oily products. The oil is called caffeol or caffeon, and consists mainly of 50 per cent furfurol alcohol and small quantities of valerianic acid, phenol, pyridine, and a nitrogenous aromatic substance (*11*).

Action of essential oil

The volatile aromatic constituents produce local irritation and reflex stimulation in the same manner as condiments. The hot water contributes to this effect; and possibly the greater reactivity induced by the caffeine heightens the reflex response (Schmiedeberg). The local irritation stimulates peristalsis, and with excessive use tends to nervous dyspepsia. It is doubtful whether the quantities taken in the beverage cause any direct central stimulation (*11*).

Coffee drinking

Essentially, the effects of coffee drinking are due to those of its alkaloids, especially caffeine. These have been fully discussed under tea [*Camellia sinensis* (Linn.) Kuntze]. The effects of excessive coffee consumption differ from tea only in minor details; while tea tends to constipation, coffee is laxative. Both interfere with digestion, but in different ways; coffee through the irritant effects of its volatile oil, tea through the coagulant action of the tannin. It may, therefore, be observed that different individuals are more injured by one than by

the other. The caffeine itself probably contributes to digestive derangement, through its vasodilator action. This may account for the common tendency to haemorrhoids (*11*).

4. PSYCHOTRIA Linn.

(Said to be from the Greek *psyche*—life: referring to the medicinal properties of some of the species.)

Botanical characters

Shrubs or small trees, rarely herbs, erect, rarely climbing or twining. Leaves opposite, rarely whorled. Stipules intrapetiolar, often connate, with often glandular axillary hairs. Flowers in terminal cymes, heads or fascicles. Calyx-tube short; limb often deciduous. Corolla-tube usually short and straight; lobes 5 (4 or 6), valvate in bud. Stamens as many, on the corolla-throat or-mouth. Ovary 2-celled; style branches 2; ovules solitary in each cell, basal. Fruit small, ovoid, globose or oblong (rarely didymous), with 2 plano-convex 1-seeded pyrenes, rarely separating into 2 cocci. Seeds plano-convex; radicle inferior.

Distribution

Tropical and subtropical regions.

Psychotria ipecacuanha Stokes

(Ipecac, Ipecacuanha)

Botanical characters

A half-shrubby perennial with annular roots. Stem decumbent or erect. Leaves ovate or obovate, acute or obtuse, entire, shortly petiolate, glabrous. Flowers arranged in bunches on terminal solitary peduncles; involucre 4-leaved.

General remarks

Ipecacuanha is a well-known drug which is official in the pharmacopoeia of many countries. It is the dried root of *P. ipecacuanha*, which is a native of Brazil, and is extensively exported from Rio de Janeiro to different parts of the world. The plant grows about 1 ft. high, and, from the slender and decumbent stem, roots are given off at intervals. Some of these roots develop an abnormally thick bark, and this thickened bark with the thickened root constitutes the drug of commerce. In India it has been successfully cultivated at Mungpoo, near Darjeeling, and in the Nilgiris, but it was in Mergui in Burma that the cultivation proved most successful.

Uses and properties

Ipècacuanha has been largely employed as an emetic, and, although it has been replaced for some purposes by apomorphine, notably in the treatment of poisoning, it still has a certain field of usefulness. It is now chiefly used as an expectorant and as a diaphoretic. Ipecacuanha root powder was formerly used in amoebic dysentery, but very large quantities were required, and it was difficult to avoid nausea and

vomiting. Rogers showed that hypodermic injection of the alkaloid emetine is quite as effective in the treatment of amoebic dysentery as oral administration of the powdered bark.

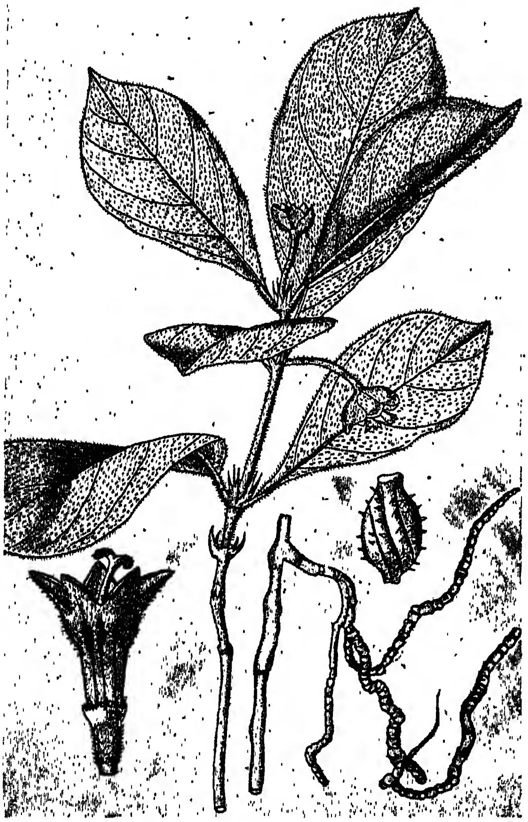

Fig. 118. *Psychotria ipecacuanha* Stokes

Constituents

Ipecacuanha contains the alkaloids emetine, cephaeline, psychotrine, o-methylpsychotrine, and emetamine. Brazilian roots contain up to 2·5 per cent of total alkaloids, of which about 70 per cent is said to be emetine (*12*). The presence of the two minor amorphous alkaloids ipecamine and hydroipecamine is also mentioned (*13*). The root also contains 0·4 per cent of a glucoside ipecacuanhin, which does not produce any marked physiological effect (*14*). The stems and leaves are said to contain about 1·13 to 1·45 per cent of the alkaloids (*15*). A sample of Indian root was found to contain 1·98 per cent of total alkaloids and 1·39 per cent of emetine (*1*).

Pharmacological action

Emetine and cephaeline, the two chief alkaloids of ipecacuanha, resemble each other closely in their effects, cephaeline being somewhat more irritant than emetine. The ipecacuanha alkaloids possess a powerful local irritant action which is, however, much more marked in certain individuals than in others. After local application to the skin, they produce irritation and inflammation resulting in the formation of vesicles and pustules. When powdering the root, the operator must protect his face, as the fine powder is very irritant to the eyes, and, when inhaled, elicits a violent reaction from the mucous membranes of the respiratory passages, profuse nasal catarrh, hoarseness, coughing, and even bad attacks of asthma and temporary amblyopia in sensitive persons or those suffering from "ipecacuanha idiosyncrasy."

The emetic action is mainly due to the irritating action of the alkaloids on the stomach, but it is possible that there may be further action on the medullary centre when large quantities are injected intravenously in animals.

Emetine

The following account of the pharmacological actions and toxic properties of emetine is taken from Chopra and Chandler (*16*) :—

"*Skin, mucous membrane and alimentary tract.* The drug is a local irritant. Applied to skin it has a pustulent action and in solutions of 1 in 500 causes a marked irritation of mucous membrane. Hypodermic injections cause some oedema and hyperaemia of the tissues and extensive capillary haemorrhages among the muscle fibres round the site of injection. Unlike cinchona alkaloids, no necrosis of tissues is observed and the action seems to be on the wall of the capillaries and arterioles. Half a grain taken by the mouth develops nausea very quickly, followed by vomiting in about an hour; an hour later loose stools accompanied by griping are passed. Nausea and vomiting can be prevented by previous administration of 60 grains of bismuth subnitrate or cerium oxalate. Much larger doses than can be borne by the mouth can be borne subcutaneously and intravenously before development of nausea, vomiting and diarrhoea; the effect would, therefore, seem to be purely local. After injection emetine can be detected in the stomach and intestines. In dogs ulceration of the gut has been produced by giving emetine subcutaneously.

"*Circulation.* On the heart of both cold-blooded and warm-blooded animals emetine has a markedly toxic effect. It depresses the excitability and conductivity of the heart muscle and produces slowing and dilation of this organ as does chloroform. Auricular and ventricular dissociation is often produced, and in most cases death is accompanied by ventricular fibrillation. In animals intravenous injections produce a fall of blood

pressure but the pressure soon regains its normal level. Subcutaneous or intramuscular injections produce no such effect.

"*Respiratory system.* There is some depression of respiration after subcutaneous doses, but after intravenous doses the respiratory centre is stimulated and the depth of respiration is increased. Small doses cause an increase of secretion of the respiratory passages and thus act as expectorants.

"*Nervous system.* In the frog emetine causes a slowly advancing central paralysis. In mammals neuritis is produced and there is general depression of the nervous functions.

"*Excretion.* Emetine is eliminated by the gut and the kidney. Excretion by the kidneys is discontinuous and prolonged. The drug appears in the urine 20 to 50 minutes after hypodermic injection of 0·04 gram ; but during the course of treatment no more than one-sixth passes by this channel. Elimination proceeds intermittently, active periods alternating with periods when little or none is found in the urine. Elimination in patients who have received 0·16 to 0·58 gram in 3 to 6 days may last 5 to 8 weeks.

"*Kidneys.* Ordinary doses have no effect ; poisonous doses irritate and may give rise to inflammation and albumin in urine, and chloride and nitrogen retention.

TOXICOLOGY

"Emetine is a very potent and toxic drug. The experiments of Dale and Dobell (1917) (*17*) showed that it has a cumulative action and that there is a serious danger in pushing on the administration beyond a certain point. Emetine toxaemia was very common in days when facts regarding its toxicity were not known ; the untoward effects after its prolonged use were put down to dysentery and this accounted for such diagnosis as post-dysenteric heart failure. Recent work has shown that undoubted cases of failure of the heart after emetine have occurred. The depressing effect of the drug if given in doses of one grain for some time is very marked, the noticeable features being general lassitude, lowness of spirits, disinclination to make an effort, tremors of muscles, quickness of pulse, feeling of faintness, loss of appetite, nausea, and in some cases difficulty of swallowing and a feeling of constriction round the throat and chest. Auscultation of the heart in these cases shows similarity of sounds and lack of muscular element in the first sound. Experiments on rabbits show that emetine acts on the parenchyma of the heart very early, producing degenerative changes in the muscle fibres. Neuritis of the lower extremities is an early symptom, sometimes appearing after a few injections. This is manifested by difficulty in

walking and in swallowing. Sensations about the throat and chest are probably due to changes in the medulla.

"*Treatment of poisoning.* Injections should be stopped and the patient should be kept strictly in bed till the heart is normal and the neuritis has disappeared."

Poisoning in animals

In animals, according to Lander (*18*), "There is very little chance of poisoning being caused in the ordinary application of this drug, large doses of which are needed to give toxic symptoms. Thus, 3 ounces are quoted by Winslow as having killed a horse, whilst Finlay Dun gives $3\frac{1}{2}$ ounces. As regards pure emetine Winslow gives 2 grains as fatal to a dog, and Finlay Dun gives for the dog $\frac{1}{2}$ to 8 grains, and for the cat $\frac{1}{3}$ grain. The latter authority describes 2 grains swallowed by a dog as having caused violent vomiting, increased mucous secretion from the respiratory and alimentary membranes, inflammation of the stomach and intestines, stupor and death in twenty-four hours (Magendie)."

Treatment. Emetics are probably unnecessary; large doses of medicinal charcoal, and stimulants after vomiting ceases are indicated.

5. RANDIA Houst. *ex* Linn.

(In honour of Isaac *Rand*, an English botanist who died in 1743.)

Botanical characters

Trees or shrubs, often thorny. Leaves often fascicled on short branches, when opposite one of the pair sometimes arrested; stipules short, intrapetiolar, free or connate. Flowers white or yellowish, in axillary or leaf-opposed cymes, sometimes fascicled, rarely solitary, often dimorphic. Corolla-tube usually with a ring of hairs within; lobes 5, twisted in bud. Anthers subsessile. Ovary 2, rarely 3–4-celled; stigma fusiform, entire or bifid. Berries globose, ellipsoid or ovoid, 2-celled, many-seeded. Seeds often embedded in pulp, angled.

Distribution

Throughout the tropics.

KEY TO THE SPECIES

a. Spines axillary. Corolla less than 1 in. diam., hairy outside. Fruit up to $1\frac{1}{2}$ in. .. .. 1. *R. dumetorum*.

b. Spines at the ends of the branchlets. Corolla $1\frac{1}{2}$–2 in. across, glabrous outside. Fruit 2–$2\frac{1}{2}$ in. .. .. 2. *R. uliginosa*.

1. Randia dumetorum Lam.*

Fl. Brit. Ind., III, 110.

Vernacular names: ARABIC—Jauzulaki, Jouzul-kosul, Juzul-kosul; ASSAM—Gurol; BENGAL—Madan, Menphal; BHIL—Gali; BURMA—Hsaythan-paya, Sethan-baya, Thaminsa; DECCAN—Gehela, Piaralu; GAYA—Manda; GOND—Katul, Kuay; GUJERATI—Medhola, Mindhal, Mindhala; HINDI—Arar, Karhar,

* Split up into three species by Gamble: *Kew. Bull.*, 1921, p. 312.

Madan, Main, Maindal, Mainhuri, Mainphal, Manneal, Manyol, Menphal; KANERESE—Aremadalu, Aremapala, Kare, Karigida, Kari-karemullu, Katmangari, Mangase, Mangari, Minakare; KHARWARI—Manda, Mowan; KOLAMI—Pato, Portoho, Potah, Potua; KONKANI—Gaddi; KUMAON—Karhar, Mainphal, Manyul; LEPCHA—Panji; MALAYALAM—Kara, Karali-kaya, Kattun-aranna; MARATHI—Galay, Gehela, Gel, Gera, Ghela, Madan, Mindhal, Monigeli, Peralu; MERWARA—Ghetu; MUNDARI—Johara; NEPAL—Amuki, Maidal, Maida-phul; PERSIAN—Juzul-kueh; PUNJAB—Arara, Mandkolla, Mindhal, Mindla, Rara; SAMBALPUR—Potwaphal; SANSKRIT—Madana; SANTAL—Boi-bindi, Loto; SIND—Jouzul-maindal, Juzul-maindal; TAMIL—Karai, Madu-karai, Makarung-kai; Maru-kallan-kay, Maru-karai, Pungarai; TELUGU—Madanamu, Manda, Manga, Mangara, Mangu, Mranga, Sinnamanga; THARU—Mana; TULU—Aremapala; UNITED PROVINCES—Karhar, Main, Maini, Mainphal, Manyul; URDU—Mainphal; URIYA—Mohana, Pativa, Potua.

Botanical characters

A small tree or rigid shrub; spines axillary, stout, straight, horizontal. Leaves 1–2 in. long, obovate, obtuse or subacute, glabrous or pubescent. Flowers solitary, rarely 2–3 on a peduncle, subsessile, greenish-yellow or white, fragrant. Calyx-tube strigose. Corolla $\frac{1}{2}$–$\frac{3}{4}$ in. diam., hairy

FIG. 119. *Randia dumetorum* Lam.

outside. Berry $\frac{3}{4}$–$1\frac{1}{2}$ in. long, globose or ovoid, glabrous or pubescent, smooth or obscurely ribbed, yellow, crowned with the peristent calyx-limb ; pericarp thick.

Distribution

Found in the Sub-Himalayan tract from the Rawalpindi district eastwards, ascending in Sikkim up to an altitude of 4,000 ft. Southwards it extends to Chittagong and peninsular India.

Uses and properties

The fruit and bark of this plant are used in indigenous medicine. The pulp of the fruit has been described as an efficient emetic by many authors ; indeed, it is used for all diseases where ipecacuanha is employed. According to Watt (*19*), it is sometimes employed to induce abortion. Haines (*20*) states that the fruit produces an uncomfortable burning sensation in the throat and is not eaten by Kols ; Moodeen Sheriff (*21*) describes the rind as slightly irritant but devoid of emetic properties. Duthie (*22*), however, remarks that the fruit is eaten when ripe, either raw or cooked It seems possible that the contradictory statements regarding the edibility of the fruit are probably due to the authors referring to different species (*see* footnote on page 552).

The unripe fruit is used to intoxicate fish, and, according to Watt (*19*), the bruised root is also employed for the same purpose.

Dymock (*23*) mentions that in Konkan the bruised fruit is mixed with stored grain to preserve it from the attacks of insects. Subramaniam (*24*) found that a 10 per cent aqueous extract of the root sprayed against the green scale of coffee gave an 80 per cent mortality of the insects in 4 days.

Constituents

The fruits contain a saponin in the pericarp, a glucosidic saponin in the pulp, and the seeds are said to contain traces of an alkaloid (*25*). An essential oil is also present (*1*).

2. Randia uliginosa DC.

Fl. Brit. Ind., III, 110.

Vernacular names : BENGAL—Piralo ; BHIL—Tapkel ; BIJNOR—Ban-pindalu ; BOMBAY—Kanthagoting, Telphetru ; BURMA—Hmanbyu, Mhanhpyoo, Mhaniben, Ny-an-gyee ; GOND—Katil, Pender ; GORAKHPUR—Paniya ; GUJERATI—Gangeda ; HINDI—Bharani, Katul, Panar, Paniah, Penaura, Pendua, Perar, Pindalu, Pindar, Pindara, Pindora ; KANARESE—Banbugri ; Dodda-kare, Garuda-kare, Kare, Olle-kare, Pandri, Pannadri, Pendri ; KOLAMI—Kumbikum, Kumkum, Pindar ; KONKANI—Pindara ; KUMAON—Pindaru ; MALAYALAM—Kara, Karei, Punan-kara ; MARATHI—Kindra, Pandhara, Panelia, Pendari, Penebra, Pendroy, Pendru, Phetra, Pindra, Telphetru ; MUNDARI—Kumbikum ; MELGHAT—Purputa ; NEPAL—Maidal ; OUDH—Panar ; PANCH MAHALS—Kauria, Kaurio ; PORBANDAR—Gangada ; PURNEA—Pindaro ; RAMNAGAR—Pindalu ; SAHARANPUR—Pandara ; SANSKRIT—Devatamalla, Gangati, Pindalu ;

SANTAL—Pendra, Pinde; TAMIL—Karai, Perungarai, Valikkarai, Vargarai, Vagata; TELUGU—Adivimanga, Devatamalle, Guaku, Guhyaku, Konda-manga, Nalla-kakasi, Nalla-kokkita, Nalaika, Nalla-manga, Peddamranga; THARU—Pirar; URDU—Pindalu; URIYA—Pendoroha, Pendra, Potua, Telkur, Tolkor.

Botanical characters

A small rigid tree. Branchlets 4-angled, bearing at their extremities 1–4 decussate spines about ½ in. long which are shorter than those of the preceding species. Leaves crowded towards the ends of branchlets, 2–8 in. long, obovate or oblong, obtuse, pubescent on the nerves beneath. Flowers solitary at the ends of suppressed branches, 1½–2 in. across, either large and sessile, or small and peduncled, white, fragrant. Corolla glabrous externally, that of the sessile flowers with a ring of hairs inside at the mouth of the tube. Stigma 2-lobed in the sessile flowers. Berry about 2–2½ in. long, ovoid, smooth, yellow, crowned with the persistent calyx-limb.

Distribution

Found in the Eastern, Central, Western and Southern India, but not common in the north.

Uses and properties

The yellow fruits are sold in markets and are eaten as a vegetable when cooked; they are used as a remedy against dysentery and diarrhoea. The foliage affords fodder for cattle and deer.

The unripe fruits of this species, like that of *R. dumetorum* Lam., are employed for poisoning fish.

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Family XLVI.—COMPOSITAE

(Sunflower Family)

Botanical characters

Herbs or shrubs, rarely trees. Leaves usually alternate; stipules 0. Flowers (florets) in heads consisting of many similar or dissimilar flowers, sessile on the dilated top of the peduncle (receptacle) and surrounded by an involucre of bracts (connate into a 2-celled utricle in the female flowers of *Xanthium*); receptacle pitted or smooth, sometimes furnished with bracteoles (*paleae, scales, bristles, fimbrillae*). Flowers all tubular (head discoid), or the outer or all ligulate (head rayed), all 2-sexual, or the inner 2-sexual or male, the outer female or neuter, sometimes dioecious. Calyx-tube adnate to the ovary; limb 0, or of hairs (pappus) or scales. Corolla gamopetalous, epigynous, regular, ligulate or bilabiate (corolla wanting in the female flowers of *Xanthium*). Stamens 4–5; filaments usually free above; anthers usually connate, the cells simple or tailed at the base. Ovary 1-celled; ovules solitary; style usually bifid. Fruit an achene, naked or with pappus. Seed exalbuminous.

Distribution

Throughout the world, especially in the mountainous tracts.

Economic aspects

This is the largest family of the flowering plants and comprises about one tenth of the phanerogamic flora of the whole world; it, however, furnishes only a few plants of economic importance.

Several plants of this family are cultivated for ornamental purposes, those commonly grown in Indian gardens being: Ageratum (*Ageratum conyzoides* Linn.); chrysanthemum (*Chrysanthemum coronarium* Linn.), a native of the Mediterranean region, known in India only under cultivation as an ornamental garden plant; the common garden chrysanthemum of India (*C. indicum* Linn.); sunflower (*Helianthus annuus* Linn.); the French marigold (*Tagetes patula* Linn.); the African marigold (*Tagetes erecta* Linn.); dahlia (*Dahlia variabilis* Desf.); *Zinnia*, *Gaillardia*, *Cosmos*, etc. Some species of *Helichrysum*, with dry "everlasting" flower-heads, are also cultivated in gardens.

Among plants of economic value may be mentioned: the cultivated lettuce [*Lactuca scariola* Linn., var. *sativa* (Linn.) C. B. Clarke] which appears to have been used as an article of dietary from very remote times (the wild variety is believed to have slightly narcotic properties); safflower or bastard saffron (*Carthamus tinctorius* Linn.) largely cultivated in India and used for dyeing; Jerusalem artichoke (*Helianthus tuberosus* Linn.) is cultivated for the thickened roots which are eaten; chicory (*Cichorium intybus* Linn.) is found wild and is also cultivated for food, fodder, and medicinal purposes. When cattle are fed on chicory in large

quantities it imparts a bitter flavour to milk and butter. The flowers contain a glucoside, cichoriin, and the milky juice a bitter substance, lactucin. Pyrethrum is obtained from *Chrysanthemum cinerariifolium* Vis. and *C. coccineum* Willd. (*C. roseum* Adam), which are now being cultivated in India and are among the most effective of insecticides. Niger seed (*Guizotia abyssinica* Cass.) is extensively cultivated in some parts of India for its oil-bearing seed. The root of costus (*Saussurea lappa* C. B. Clarke) from Kashmir is of great commercial importance, and is largely exported to China for preparation of incense and as a fumigant; it is also used in perfumery and in medicine (*1*). In India it is used to protect woollen fabric from insects. It is believed by Indian ladies that the root does not tarnish the gold embroidery of their clothing as is the case if naphthalene were used.

Medicinal and toxic aspects

Bitterness is the prevailing characteristic of the plants of this family. Several species are not liked by livestock. Therapeutically these may be divided into two groups: (*a*) The *Tubiflorae* which are generally bitter, tonic, stimulant and astringent, and in many instances diaphoretic, diuretic and laxative; (*b*) the *Liguliflorae* which are milky, bitter, astringent, and sometimes narcotic.

Amongst the medicinal plants may be mentioned the foreign elecampane (*Inula helenium* Linn.—*non* Hook. *f.* & Thoms.), which is a mild tonic and contains inulin, alantolactone (helenin), and a volatile oil; pellitory of Spain (*Anacyclus pyrethrum* DC.), which is largely imported into India from abroad and contains "pyrethrin" (pellitorine). Wormseed or santonica (*Artemisia maritima* Linn., forma *rubricaule* Badhwar or *A. brevifolia* Wall.) from wild sources in Kurrum Agency and Kashmir in India yields the well-known drug santonin, which is largely used as an anthelmintic. Dandelion (*Taraxacum officinale* Weber) contains bitter principles, and is used as a mild laxative and tonic; it is also used as a potherb in Kashmir. Roman chamomile (*Anthemis nobilis* Linn.) is used as a tonic and stomachic; the German chamomile (*Matricaria chamomilla* Linn.) is also used for the same purpose. Coltsfoot (*Tussilago farfara* Linn.) is a bitter astringent containing much mucilage, and is used against asthma.

From amongst the poisonous plants the following may be mentioned: Arnica (*Arnica montana* Linn.), which is imported into India for medicinal purposes, contains the acrid bitter principle arnicin. Its tincture is liable to produce a form of dermatitis. The dried flower-heads are gastric and intestinal irritants. *Baccharis cordifolia* DC., the mio mio of South America, contains a yellowish-green poisonous oil (baccharis oil). The aqueous extract of the plant is poisonous to rabbits (*2*). In Europe animals have been reported to be poisoned by grazing on the

herbage of tansy (*Tanacetum vulgare* Linn.). The oil of tansy is used as an abortifacient, in many cases with fatal results. It contains thujone, which also occurs in *Thuja orientalis* Linn. of Coniferae; this has been called "tanacetone" and is identical with "absinthiol" obtained from absinthium (*Artemisia absinthium* Linn.) and with "salviol" from *Salvia* of the Labiatae family. Half an ounce of oil of tansy has produced death after two to four hours, with convulsions and unconsciousness (*3*). The genus *Senecio* is of considerable toxicological interest in some foreign countries. Some species have from time to time been regarded as the cause of the well-known "Molteno cattle disease", "straining sickness" or "ragwort" poisoning in horses and cattle, and contain toxic alkaloids, such as senecifoline, senecifolidine, senecionine, squalidine, retrorsine, jacobine, etc. There are about sixty-five uninvestigated species of *Senecio* growing in India. The white snakeroot (*Eupatorium urticifolium* Linn. *f.*) of America is said to produce the disease known as "trembles" in cattle, horses and sheep, and "milk sickness" in man. The symptoms consist of weakness and ataxia, ending in death. Nothing is known about the toxicity of the Indian species. Some foreign species of *Eupatorium* are used as a diaphoretic in the form of an infusion, as tea. Staggerweed (*Matricaria nigellifolia* DC.) of South Africa has been stated to be responsible for the disease known as "staggers" or the "pushing disease" of cattle. The symptoms are referable to the disturbance of the central nervous system, the most marked symptom being the tendency of the animal to push its head against any obstacle, such as trees, fences, hedges, etc. In acute attacks general tetaniform convulsions may occur, and intoxication is marked by a latent period. An interesting condition known as "kaalsiekte", an alopecia affecting kids and lambs, has been described by Steyn (*4*). This results from the mothers eating *Chrysocoma tenuifolia* Berg., which produces considerable loss in some districts of the Cape Province. The plant is poisonous to sheep and goats, but tolerance is acquired to a remarkable degree if the animals were previously treated with nontoxic doses. *Geigeria passerinoides* Harv., *G. aspera* Harv., *G. zeyheri* Harv., and *G. pectidea* Harv. of South Africa have been reported to produce under certain conditions in livestock, chiefly goats and sheep, a disease known as "Vermeersiekte" or "Misbeksiekte." This disease is characterized by continuous vomiting and diarrhoea, and is often accompanied by hoven and stiff gait. Death occurs in a variety of ways; the commonest type, however, is said to be that in which vomiting is accompanied by cough, weakness, loss of condition, and death due to exhaustion. Some foreign representatives of the genera *Dimorphotheca*, *Aster*, *Atractylis*, *Helenium*, and *Centaurea* are also recorded as

poisonous. *Lactuca virosa* Linn. of Europe is not willingly eaten by animals; the dried milky juice of this plant is the well-known lactucarium which is narcotic.

Some species of *Xanthium* are reported to be poisonous, and of these *X. strumarium* Linn. (burweed, cocklebur) is found in India. Jersey cudweed (*Gnaphalium luteo-album* Linn.) is suspected of causing poisoning in South Africa; this plant is also found in India. Wormwood (*Artemisia absinthium* Linn.) contains a volatile oil which has a powerful stimulant action on the brain and in large doses produces convulsions and death. It also contains the bitter substance known as absinthin. The oil is one of the ingredients of the well-known French liqueur "absinthe". 'Mundi' or 'gorakh-mundi' (*Sphaeranthus indicus* Linn.) is used to kill fish and crabs.

The spiny character of the leaves and involucres of some of the plants of this family, *e.g.*, *Centaurea*, *Silybum*, etc., is responsible for mechanical injuries caused by these plants.

Constituents The members of this family have been found to contain: (*a*) *alkaloids*, such as senecionine, senecifoline, senecifolidine, jacobine, retrorsine, squalidine, jacodine, seneciphylline, platyphylline, etc., (*b*) *pungent amides*, such as pellitorine, spilanthol, etc., (*c*) *glucosides*, such as achillein, centaurein, dicomid, grindelol, cnicin, vernonin, absinthiin, potassium atractylate, eurybin, cichoriin, xanthostrumarin, etc., (*d*) *bitter substances*, such as those found in *Arnica*, *Artemisia*, *Lactuca*, *Cichorium*, *Tanacetum*, etc., (*e*) *lactones*, such as santonin, temisin, alantolactone, etc., (*f*) *saponins*, such as those from *Calendula*, *Bellis*, *Taraxacum*, *Zinnia*, *Aster*, etc., (*g*) *toxic esters*, such as pyrethrin I and pyrethrin II, and (*h*) *essential oils*, such as oils of elecampane (containing alantolactone), chamomile, absinthe or wormwood (containing thujone), etc.

KEY TO THE GENERA*†

Series I. *Tubiflorae*. Flowers all tubular or the outer only ligulate. Juice usually watery.

A. Heads homogamous; flowers all bisexual, tubular, never yellow. Anthers cleft at the base, not tailed. Style-arms subulate, hairy.

a. Heads distinct, many-flowered.

Achenes 8–10-ribbed; pappus short, fugaceous .. 3. *Centratherum*.

* This is one of the most easily recognizable families, but the further diagnosis of genera and species is very difficult. For this reason it has been thought desirable to give an elaborate key in which the genera discussed hereafter are properly placed under the Tribes and Subtribes to which they belong. This arrangement would also help in distinguishing the poisonous Indian genera from others growing in India. The capital letters denote the Tribes and small ones the Subtribes.

† The roots of *Anacyclus pyrethrum* DC., a foreign plant, are imported into India for use in medicine. This plant is, therefore, also discussed in detail.

B. Heads homogamous; flowers all bisexual, tubular, rarely orange, never yellow. Anthers subentire at the base. Style-arms obtuse, papillose. Pappus usually setose. Leaves opposite or alternate.

a. Anther-tip appendiculate. Achenes 5-angled.

Pappus of slender hairs. Involucral bracts many .. 6. *Eupatorium*.

C. Heads heterogamous, rayed or discoid, or homogamous and rayless. Anther-bases subentire, not tailed. Style-arms flattened or plano-convex, all or those of the disc-flowers terminated by a cone. Receptacle almost always naked. Disc-flowers yellow; ray-flowers yellow, white or purple.

a. Ray-flowers female, ligulate, never yellow. Pappus-hairs long, copious.

Outer involucral bracts green, narrow. Ligules few-seriate .. .. 5. *Erigeron*.

D. Heads heterogamous, rayed or discoid, or homogamous and rayless. Anther-bases tailed. Style-arms linear, obtuse, or the style of the sterile flowers undivided. Disc- and ray-flowers usually both yellow.

a. Heads androgynous. Involucral bracts dry or herbaceous, rarely subscarious. Receptacle naked. Style-arms of bisexual flowers filiform, not truncate, or the style of the sterile flowers undivided.

§. Heads in dense, globose or ovoid masses. Corolla of female flowers filiform.

Herbs with winged stems. Pappus 0 .. 11. *Sphaeranthus*.

b. Heads androgynous or homogamous, discoid. Involucral bracts scarious, usually hyaline. Receptacle usually naked. Style-arms of bisexual flowers truncate. Herbs.

§. Bisexual flowers all or mostly fertile, with divided styles.

Female flowers 2–many-seriate. Pappus-hairs never barbellate .. .. .. 7. *Gnaphalium*.

c. Heads heterogamous, rayed, rarely subdisciform, or homogamous and rayless. Flowers usually all fertile. Receptacle naked. Style-arms of bisexual flowers rounded or dilated at the apex.

Heads rayed. Pappus-hairs few or many, subequal. Achenes ribbed .. .. .. 8. *Inula*.

Heads usually rayed. Receptacle paleaceous. Anther-bases not tailed. Style-arms truncate or appendiculate; or the style of the sterile flowers undivided. Achenes 3–4-angled or terete or compressed. Pappus of 2–4 bristles or paleaceous or 0. Leaves, at least the lower ones, opposite.

a. Heads heterogamous or unisexual. Bisexual flowers sterile, with undivided styles; female flowers apetalous. Anthers nearly free, with inflexed appendages.

Involucral bracts of male flowers free, of female forming a 2-flowered, 2-celled capsule armed with glochidiate spines .. .. .. 12. *Xanthium*.

F. Heads heterogamous, rayed or disciform, or rayless and homogamous. Involucral bracts 2–many-seriate. Receptacle naked or paleaceous. Anthers not tailed. Style-arms truncate. Pappus 0 or a crown of short paleae. Disc-flowers yellow; ray-flowers variously coloured.

§. Receptacle paleaceous. Heads usually rayed.

Achenes 4–5-angled or many-ribbed. Heads peduncled .. .. 1. *Anthemis.*

§§. Receptacle naked or with fimbriate pits.

1. Heads rayed, usually long-peduncled. Achenes 5–10-ribbed .. .. .. 4. *Chrysanthemum.*
2. Heads small, disciform, racemose or panicled .. 2. *Artemisia.*

G. Heads heterogamous, rayed or disciform, or homogamous and rayless. Involucral bracts usually 1-seriate and subequal, with a few short outer bracteoles at their base, rarely many-seriate. Anther-bases obtuse or with 2 short points, rarely tailed. Style-arms of bisexual flowers truncate or appendaged. Pappus of fine hairs. Disc-flowers yellow; rays usually also yellow.

a. Involucral bracts 1–2-seriate, free nearly to the base, usually with a few smaller outer ones. Style-arms of bisexual flowers truncate or obtuse, penicillate or with a hairy tip.

§. Involucral bracts narrow, with a few much shorter outer ones (except some species of *Senecio*).

Heads heterogamous, rayed (rarely homogamous and rayless). Style-arms usually truncate .. 10. *Senecio.*

Series II. *Liguliflorae.* Flowers all ligulate. Juice milky.

H. Heads homogamous. Corollas all ligulate; ligule truncate, tip 5-toothed. Anther-bases sagittate, rarely tailed. Style-arms slender. Leaves never opposite.

a. Herbs, rarely shrubby below, glabrous or hispid, rarely scapigerous. Achenes usually narrowed below, beaked or not above. Pappus-hairs many, simple.

Achenes compressed, beaked . . . . 9. *Lactuca.*

ANACYCLUS Linn.

Anacyclus pyrethrum DC.

(Pellitory of Spain)

Vernacular names: ARABIC—Aaqarqarha, Aquarqarha, Audulqarha, Udalqarha; BENGAL—Akarkara; BOMBAY—Akarkara; DECCAN—Agalgoru; GUJERATI—Akorkaro; HINDI—Akarkara; KANARESE—Akkalakaro; MARATHI—Akkalkadha; SANSKRIT—Akarakarava, Akarakarabha; TAMIL—Akkalkara, Akkirakaram; TELUGU—Akkalkara, Akkirakaram.

Source Large quantities of the root of this plant are imported into India chiefly from Algeria.

Uses and properties In European medicine, the roots are chiefly used as a sialagogue and to afford relief in toothache. They have stimulant properties, and, when locally applied, act as irritant and rubefacient. In India an infusion made from the root with lesser galangal (*Alpinia officinarum* Hance, imported from China) and ginger (*Zingiber officinale* Rosc.) is used

as a cordial and stimulant, and is believed to be useful in certain stages of typhus fever. In larger doses, the powdered root is an irritant to the mucous membrane of the intestines causing bloody stools, tetanus-like spasms, and profound stupor (*5*).

Constituents

The active constituent of the root is pellitorine. Ott and Behr called this substance "pyrethrin" whilst Gulland and Hopton designated it as "*pellitorine*" (*6*). In view of the selection of the name "pyrethrin" for the active principle of pyrethrum flowers, it would be better not to adopt this name for the active constituent of this plant. Pellitorine is the isobutylamide of either undecadienic acid or nonadienecarboxylic acid. It is physiologically analogous to piperine (*6*).

A pharmacodynamic study of the neuro-muscular toxic activity of pellitorine has been made. It is more active on fish, crustacea, and cephalopod molluscs. The echinoderms are unaffected by it (*7*).

1. ANTHEMIS Mich. *ex* Linn.

(Greek name of chamomile, from *anthos*—a flower.)

Botanical characters

Herbs. Leaves deeply toothed or pinnatisect. Heads terminal, peduncled, rarely corymbose, heterogamous and rayed (very rarely disciform); ray-flowers female, 1-seriate, tube terete or 2-winged, ligule spreading; disc-flowers bisexual, tube compressed or 2-winged, base usually 1–2-gibbous, limb 5-fid. Involucre hemispheric; bracts many-seriate, rigid, margins scarious, outer shorter; receptacle convex or elongate; paleae rigid or hyaline, sometimes embracing the flowers. Anther-bases obtuse. Style-arms of bisexual flowers with truncate penicillate tips. Achenes 4–5-angled, 8–10-ribbed or many-striate, truncate; pappus 0 or very short, paleaceous or of a membranous large or small auricle.

Distribution

Europe, North and West Asia, and North Africa.

Anthemis cotula Linn.

Fl. Brit. Ind., III, 312.

(Dog Camomile, Dog Chamomile, Dog Fennel, Mayweed)

Botanical characters

A foetid-smelling, acrid, erect annual, 8–18 in. high, corymbosely branched. Leaves gland-dotted, segments very narrow. Heads 1–1½ in. diam. Ray-flowers usually neuter, white; disc-flowers winged, dilated below. Paleae of conic receptacle linear or setaceous. Achenes caducous, turbinate, tubercled, naked, tip crenulate.

Distribution

Found in Baluchistan and probably also in Sind.

Toxicity

The strong foetid odour and acrid taste make this plant extremely undesirable for livestock, and, according to Pammel (*8*), it blisters the skin.

Constituents

The whole fresh plant yields about 0·01 per cent and fresh flowers about 0·013 per cent of an essential oil (*9*).

FIG. 120. *Anthemis cotula* Linn.

2. ARTEMISIA Linn.

(The classical name of some species of the genus : *Artemis* is the Greek Diana.)

Botanical characters

Herbs or shrubs, usually strong-scented. Leaves entire, incised or 1–3-pinnatisect. Heads small, disciform, homogamous or heterogamous, solitary or fascicled, racemose or panicled ; outer flowers female, 1-seriate, with 2–3-toothed corollas ; inner flowers bisexual, with 5-fid corolla-limb. Involucral bracts few-seriate, outer shorter, margins scarious. Receptacle naked or hirsute. Anther-bases obtuse. Style-arms of the bisexual flowers truncate, often penicillate; tips often connate in sterile flowers. Achenes very small, faintly striate; pappus 0.

Distribution

North temperate regions; a few in South America.

Medicinal and toxic aspects

The plants belonging to this genus are bitter, stimulant, tonic, deobstruent, antispasmodic, and anthelmintic. Some of the species are suspected of being poisonous to livestock in South America, but no specific cases have been reported. The essential oil from *A. absinthium* Linn. acts as a narcotic poison in large doses, and the volatile oil from several members of this genus probably has similar properties. Santonin,

the well-known drug used against roundworms, is obtained from *A. maritima* and closely allied plants or varieties of the same.

KEY TO THE SPECIES

A. Heads homogamous; flowers all fertile; receptacle naked .. 2. *A. maritima.*
B. Heads heterogamous.
- *a.* Leaves 1–2 in. long, unequally 2–3-pinnatifidly cut into linear segments. Receptacle covered with long hairs .. .. 1. *A. absinthium.*
- *b.* Leaves 2–4 in. long, 1–2-pinnatisect. Receptacle naked .. .. 3. *A. vulgaris.*

1. Artemisia absinthium Linn.

Fl. Brit. Ind., III, 328.

(Absinth, Absinthe, Absinthium, Wormwood)

Vernacular names: ARABIC—Afsantin; HINDI—Vilayati-afsantin; MALAYALAM—Shulabandha; PERSIAN—Afsantin; SANSKRIT—Damar.

Botanical characters

A very aromatic herbaceous perennial, almost silkily hoary; stem 1–3 ft., erect, angular, ribbed. Leaves 1–2 in., ovate or obovate, unequally 2–3-pinnatifidly cut into spreading, linear or lanceolate, obtuse segments. Heads heterogamous, numerous, $\frac{1}{8}$–$\frac{1}{4}$ in. diam., hemispheric, in drooping secund racemes terminating the branches. Flowers yellow; ray-corolla dilated below; receptacular hairs long, straight.

Distribution

Met with in Kashmir and Kurrum Agency at altitudes of 5,000 to 7,000 ft.

Uses

The whole herb is an aromatic tonic, and formerly enjoyed a great reputation in the treatment of dyspepsia and subnormal activity of the digestive organs. It was also frequently used as an emmenagogue, febrifuge, and anthelmintic. An evidence of the last-named use is found in the name "vermouth" (*vermis*=worm), but it is now little used for this purpose. The dried leaves are used to protect garments from moths and other insects.

Constituents

The herb contains a volatile oil, absinthe or wormwood oil, which varies from 0·12 to 0·51 per cent of the fresh herb according to the source from which it is obtained (*10*). Its chief constituent is thujone, which produces physiological effects similar to those of camphor (*11*).

The plant also contains a bitter glucoside, absinthin (*12*), and a bitter substance called anabsinthin (*10*).

The toxic action of the plant is ascribed to the essential oil, and the tonic effects are due to absinthin (*13*).

Toxicity and poisoning

In mammals, intravenous injections of absinthe oil (1 to 3 drops for a cat) produce unconsciousness and general clonic and tonic convulsions

of epileptiform type. The clonic spasms are due to a stimulation of the motor areas, for they become tonic if the cerebral arteries are clamped. The tonic spasms are of medullary origin. In man, overindulgence produces similar effects, and is said to lead to mania (*13*). The detailed symptoms and the literature on the subject are fully discussed by Meyers (*14*).

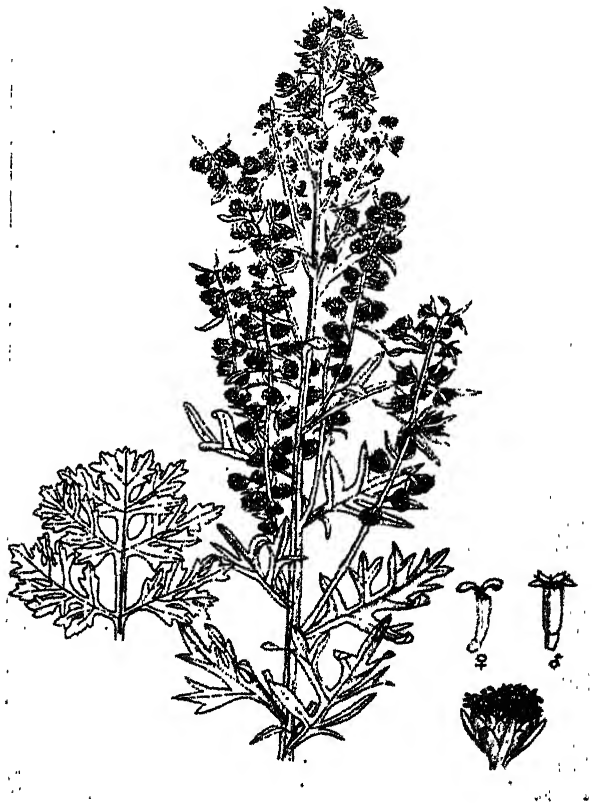

FIG. 121. *Artemisia absinthium* Linn.

The French liqueur " absinthe " and the tonic wine " vermouth " contain this oil combined with oil of anise, fennel, and other substances. Excessive use of " absinthe " gives rise to certain symptoms which are different from those produced by alcohol. They are, therefore, attributed to this essential oil and given the name of absinthism.

Absinthe was at one time very largely used in France as an " aperitif " and as a stimulant to overcome fatigue, but the evil effects produced

by it led to the passing of the French act of 1872, by which the trade in this liqueur was put under severe restrictions. Its use has been prohibited in the French Army and Navy. In small doses it has undoubtedly an exhilarating effect, but habitual or excessive use brings on gradual diminution of the intellectual faculties, paralysis, epileptiform convulsions, combined with the usual effects of chronic alcoholic poisoning, and ending in delirium or death. Absurd and extravagant statements have undoubtedly been made regarding the injurious effects of absinthe, but it is an established fact that overindulgence in absinthe is more harmful than any other alcoholic drink. The passage* "He hath made me drunk with wormwood", doubtless refers to this plant. It is also sometimes added to hops to make the beer more exhilarating.

The oil is not likely to be taken except for medicinal purposes or as a constituent of certain liqueurs. In larger doses the oil is a violent narcotic poison, causing stupor, convulsions, dilated pupils, foaming at the mouth, and a tendency to vomit. Pammel (*8*) describes a case where half an ounce of the oil caused severe symptoms as described above.

According to Watt (*15*), the plant "exercises a powerful influence over the nervous system, and its tendency to produce headache and other nervous disorder is well known by travellers in Kashmir and Ladak, who suffer severely when marching through the extensive tracts of the country covered with this plant". The authors, however, have not seen any extensive tract covered with the plant in Ladak and Kashmir.

2. Artemisia maritima Linn.

Fl. Brit. Ind., III, 323.

(Levant Wormseed, Wormseed, Santonica)

Vernacular names: ARABIC—Afsantin-el-baher, Sarifun, Sariqun, Shih, Shiharmani; BHOTIA—Safed-purcha; BOMBAY—Kira-maniova; KASHMIR—Murin, Murni; PUSHTO—Tarkha; PERSIAN—Afsantin-ul-bahr, Sariqun, Shih.

Botanical characters

A shrub with stout, branched rootstock; stems up to 3½ ft. high, slender, much branched from the bases, striate. Leaves 1–2½ in., often quite white, 2-pinnatisect, segments very many, small, spreading, linear, obtuse; upper leaves simple linear. Flower-heads homogamous, numerous, ellipsoid, oblong or ovoid, slightly over $\frac{1}{10}$ in. long, 3–10-flowered, in spicate fascicles in the axil of a small linear leaf. Receptacle naked.

Distribution

Found in the Western Himalayas from about 5,000 to 16,000 ft. and in Tibet.

* From "Lamentations of Jeremiah" Chapter III, 15.

Source of santonin

This plant is the source of the important drug santonin. On account of the difficulties in correct identification and lack of knowledge with regard to the proper collection of the santonin-yielding artemisia, manufacture of santonin could not be satisfactorily developed in India till Badhwar (*16*) carried out extensive studies both in the field and in the laboratory. He showed that the santonin-yielding artemisia from Kurrum has 3, rarely 4 flowers in each head, and has reddish stems in the early stages of its growth. This has been named as forma *rubricaule* by Badhwar (*16*). There exists a form in Kurrum which cannot be distinguished from the forma *rubricaule* by any botanical character except that it has greyish stems in the early stages of growth. This distinction disappears after the month of June when the stems in both cases become greyish. The form with greyish stems in early stages is devoid of santonin* in all parts of the plant throughout its life history, while the one having reddish stems in early stages has been found to yield up to 1·8 per cent of santonin in the immature flower-heads. In addition to these forms, there are present in Kurrum the two varieties referred to by Clarke in his "Compositae Indicae", *viz.*, *A. maritima* Linn., var. Hook. *f.* & Thoms. and var. *thomsoniana*. The former has absolutely no smell, is totally devoid of hairs, and is sticky to touch on account of a large amount of resin secreted by it. It does not contain santonin, and, as suggested by Badhwar (*loc. cit.*), deserves a specific rank. The variety *thomsoniana* has a much stronger odour than the santonin-yielding form, and is very woolly through a dense covering of whitish hair. The flower-heads are comparatively very few in number and contain 6 to 10 flowers each. This is also devoid of santonin. The Kashmir santonin-yielding artemisia resembles the variety *thomsoniana* but, unlike it, yields up to 2·4 per cent of santonin. In this case, however, it is the leaves that are important from the standpoint of santonin, as opposed to the Kurrum artemisia where the immature flower-heads are the important parts. It should be understood that in both cases the leaves and flower-heads contain santonin, but the commercial importance of one or the other in different places is due to the difference in the habit of the plant. The Kurrum artemisia has numerous closely packed flower-heads while the Kashmir artemisia has comparatively much fewer and distant flower-heads. In commercial collection, therefore, large amount of "sticks" get mixed up with flower-heads in the case of Kashmir artemisia, and this lowers the percentage of santonin. It must be borne in mind

* This form was found to contain a principle designated as pseudo-santonin by the chemists of the firm of Messrs. T. Smith in England, but Badhwar failed to obtain the same by the method described and from the samples supplied by this firm or collected by him.

that the roots and the stems have no santonin. By the regulation of the time and method of collection and other matters connected with the industry by Badhwar, it is now possible to obtain more than 1 per cent of santonin from Kurrum and Kashmir artemisias on a commercial scale, although individual samples have been found to yield as much as 2·4 per cent. This is as good as the published figures of artemisia from Russian Turkestan show. Before the Great War, practically the whole of the santonin supply of the world came from Russia, but during the last fifteen years the position has altered, and India figures prominently in the santonin trade. In addition to Kurrum and Kashmir, santonin-yielding artemisia is found in Waziristan, Tribal Territories on the North-West of India, and in Afghanistan. Badhwar has also examined *A. scoparia* Waldst. & Kit., *A. tournefortiana* Reichb., *A. absinthium* Linn., and *A. parviflora* Buch.-Ham. *ex* Roxb. from the Kurrum Agency, but none of these was found to contain santonin (*16*).

A. maritima is a powerfully aromatic herb and produces severe headache in persons unaccustomed to its influence in the field as well as in godowns where it is stored. The high altitude at which the plant grows and the resultant rarefied atmosphere has an additional effect. The severity of the symptoms, however, differs in different persons and generally lasts for the first few days. It is interesting to note that the plant is browsed upon by sheep and goats in the field, without any ill effects.

The following account of the action and toxic effects produced by santonin has been taken from "Anthelmintics and Their Uses" by Chopra and Chandler (*17*) :—

Uses

" Santonin is a classical remedy for the treatment of Ascaris and Oxyuris infections. It is obtained from *Artemisia maritima* Linn., a plant which was used by the ancient Greek and Roman physician as a remedy to expel intestinal parasites. To the old Arabian and Persian physician the plant is well known as *Shih, Sarifun* or *Afsan-tin-el-baher*; they used the flowering tops extensively as a vermifuge. The introduction of the remedy into India was due to them, as previously no mention was made of the drug by the ancient writers of Hindu medicine. The Mohammedan physicians gave the powdered flowering tops in 2 to 4 drachm doses either alone or in combination with some purgative. Besides having anthelmintic properties, it was also considered useful in hiccough and ascites, and was externally applied to inflammatory swellings in the body in the form of a paste with water."

Constituents

The important constituents of *A. maritima* are: an essential oil, which has an odour resembling cajuput oil and camphor and contains

cineole, thujone, camphene, etc., a lactone, santonin, which is responsible for the anthelmintic properties, a lactone temisin, and a bitter substance.

" Santonin is an acid anhydride having the formula $C_{15}H_{18}O_3$. It is considered to be the inner anhydride or lactone of santonic acid, which is a derivative of naphthalene. Santonin is very sparingly soluble in cold water. It is soluble in 40 parts of cold rectified spirit and in 3 parts at boiling point. It is also soluble in 4 parts of chloroform, in fats, and in alkaline and acid solution. Santonin crystallises in flattened rhombic prisms, in feathery radiating groups. It is odourless, tasteless at first, but afterwards develops a bitterish taste. The cold alcoholic solution has an extremely bitter taste. On sublimation it becomes reddish brown and evolves white fumes and on cooling sets to a clear brown vitreous mass which is reddened on treatment with a little dry alkali, *e.g.*, slaked lime. Santonin has a melting point of 169° to 171°C. and has a specific gravity of 1·1866. It is laevo-rotatory when dissolved in chloroform. On exposure to light, especially to direct sunlight, santonin acquires a yellow colour forming the so-called ' golden santonin ' or ' chromo-santonin.'

Action

" Externally santonin has little effect. Taken by the mouth it is non-irritant and almost tasteless, but develops a slightly bitterish taste after a short time. In the stomach it is dissolved in the acid of the gastric juice and may be partly absorbed. If taken fasting the liability to absorption is increased and toxic action will predominate over the anthelmintic effect. In order to avoid the risk of absorption and possible poisoning it is advisable not to give it on an empty stomach.

" After absorption, the drug has little effect on the circulation. The frog's heart is depressed. The respiration is not affected and even in poisonous doses it is not paralysed.

" The symptoms produced by the absorption of the drug in small quantities chiefly pertain to the special senses. Anomalies of vision, colour perception, and hearing are not infrequent with therapeutic doses, even when other symptoms of poisoning are absent. Xanthopsia or yellow vision is a common occurrence and this may persist for some hours and then disappear. The white light at first appears to have a violet and later a yellowish green hue, and the whole field of vision is tinted with these colours and visibility in dim light is lessened. It has been shown that this effect is mostly peripheral.

Toxic effects in animals

" When larger quantities enter the circulation, convulsions appear. In dogs, the first effect is twitching of the muscles of the head, frequently starting on one side. These are followed by rolling of the eye balls, grinding of the teeth, and side to side movements of the head, ending

in epileptiform convulsions resembling those met with in strychnine poisoning. During convulsions the respiration may become irregular and slow and may fail to return, the animal dying of asphyxia. In frogs convulsions are produced as in mammals, but after a prolonged depression. The clonic nature of the convulsions points to the action of the drug on the brain rather than on the spinal cord. The medulla usually escapes and only in very severe poisoning does the respiratory centre become paralysed.

Fate in body

" It was believed that most of the santonin left the body unchanged in the faeces and only small quantities were absorbed and were oxidised in the tissues to santogenin and other derivatives. Recent investigations by Marshall (*18*) tend to show that after medicinal doses santonin is almost wholly excreted in the urine as a coloured compound which is possibly of the same nature as the coloured substance transiently formed during the action of caustic alkalies on santonin. This coloured substance occurs in the blood plasma and is not formed in the kidneys. It may be found in the faeces and is probably formed in part before absorption. Marshall has also shown that there is a distinct relationship between the excretion of this substance and xanthopsia. The urine assumes an orange or intensely yellow colour, or sometimes a greenish or saffron colour if it is acid ; if the urine is made alkaline a purplish red or bright scarlet colour is produced.

" The yellow colour in the urine may be confused with that given by anthracene purgatives such as rhubarb whose active principle, emodin, is excreted in the urine. This can, however, be easily distinguished from santonin coloration since when shaken with ether the emodins are taken up, while the santonin colouring matter is not; emodins can also be precipitated with lime and barium water while santonin cannot. Large doses of santonin produce irritation of the kidneys and pain on micturition, and blood may appear in the urine.

Toxic effects in man

" In man, large doses of santonin cause poisoning. In children, small doses such as 1 grain (0·06 gram) have produced serious poisoning, and several fatalities have been recorded. In adults 3 grains (0·2 gram) cause only slight symptoms ; larger doses may produce serious poisoning, yet doses as large as 7½ to 15 grains (0·5 to 1·0 gram) have been taken without producing serious effects. A certain amount of absorption occurs in almost all cases as is evident from intensely yellow urine and xanthopsia. Symptoms of poisoning vary from slight manifestation of anomalies of perception to convulsions, coma and death. In the first stage the objects have a bluish or violet tinge ; later they have a deep yellow hue. This stage is of a short duration and may remain unnoticed by the patient. The stage of ' yellow vision ' is of longer duration ;

all bright objects appear yellow and dark blue, and violet appears black. The patient gets headache, confusion of thoughts, and vomiting may occur. These symptoms may pass off without any further effects becoming noticeable. When large quantities gain access to the circulation the phenomena of severe intoxication become evident. These are vomiting, colicky pains in the abdomen, diarrhoea, cold sweats, and depression of respiration and heart. The kidneys and the urinary passages are irritated, producing very painful micturition and haematuria. Sometimes a rash appears on the skin. The patient complains of headaché, vertigo, weakness, and somnolence which passes on to unconsciousness. There are tremors, speech is lost, and finally convulsions of an epileptiform nature supervene ; there may be tonic spasms of muscles. Binz has observed that convulsions may be confined to only one side of the body, but this is a very rare condition

Treatment of santonin poisoning

" The stomach should be immediately emptied with a stomach tube and a saline purgative and an enema should be given. If convulsions are present, a centrally acting emetic such as apomorphine should be given, and enemata may be administered at the same time. Repeated doses of chloral or inhalation of ether or chloroform may be tried to control convulsions. Collapse should be combated by giving stimulants."

SANTONIN AS AN ANTHELMINTIC

Anthelmintic in man

" According to Hare santonin acts best when combined with 2 or 3 grains of calomel and followed six hours later by a saline purgative. Calomel stimulates the liver and the presence of bile, as has already been pointed out, greatly enhances its toxic action on the parasites.

" For children a good rule is to give $\frac{1}{6}$ grain (0·01 gram) for every year of age, for adults 1 to 5 grains (0·06 to 0·3 gram).

" It should be borne in mind that santonin is a toxic drug which should be given with caution. On no account should it be prescribed unless the diagnosis is made by thorough examination of the stools.

" Santonin is quite effective in removing younger oxyuris or pinworms from the small intestine, $\frac{3}{4}$ to $1\frac{1}{2}$ grains being given for several days in succession. Since it has little effect on the worms situated lower down in the bowels, it cannot be depended on, by itself, to cure oxyuris infections."

Recent observations on the anthelmintic properties of santonin have in part confirmed the reputation which it has long enjoyed, for Caius & Mhaskar (*19*) cured 16 out of 20 cases infected with ascaris. Brown (*20*), however, who would place the cure rate at between 60 to 80 per cent,

regards santonin as inferior both to hexyl resorcinol and chenopodium in the treatment of ascaris infections.

" Santonin is rather an expensive drug to be used in animals, and is only recommended for very valuable animals. Horses ½ drachm (2·0 gram); sheep 10 to 15 grains; pigs 5 to 10 grains; dogs 1 to 5 grains. For dogs and cats ¼ grain per kilo of body weight is recommended with 1 to 2 grains of calomel, either in the form of a pill or in milk. Some authorities suggest giving it in castor oil followed by another dose of the oil 6 hours later. The drug should be given to dogs with caution as it is liable to produce symptoms of poisoning already described. It is effective against roundworms in puppies, but it is not advisable to give it until the animals are eight weeks old." *Anthelmintic in animals*

3. **Artemisia vulgaris** Linn.

Fl. Brit. Ind., III, 325.

(Fleabane, Indian Wormwood, Motherwort, Mugwort)

Vernacular names: BENGAL—Nagdona; BOMBAY—Dhor-davana, Nagdona; DECCAN—Davan, Ran-davan; DEHRA DUN—Samri, Sarmi; GARHWAL—Kunja; HINDI—Dona, Gathivana, Majtari, Mastaru, Nugdouna; KANARESE—Davana, Manjipatri; KASHMIR—Tithvan, Titvan; LEPCHA—Taknyel; MALAYALAM—Appa, Damanakam, Kattuchatti, Makkippu, Mashipatri, Nilampala, Rirunittipacha; MARATHI—Gathona, Surband; NEPAL—Titapat; PUNJAB—Afsuntin, Banjiru, Buimadaran, Chambra, Tataur, Ubusha; SANSKRIT—Granthiparni, Nagadamani; TAMIL—Machipatri; TELUGU—Mashipatri; URIYA—Doyona, Gonddhomaro, Nagodoyona.

Perennial, aromatic, shrub-like herb, 2–8 ft. high, pubescent or tomentose. Lower leaves petioled, 2–4 in. long, ovate, 1–2-pinnatisect, with stipule-like lobes at the base, ashy-grey or white-tomentose beneath; upper leaves sessile, entire or 3-fid. Heads sessile or shortly pedicelled, heterogamous, ovoid or subglobose, $\frac{1}{8}$–$\frac{1}{6}$ in. long, arranged in subsecund spike-like panicled racemes, brownish-yellow; receptacle naked.—A very variable plant as regards the leaves and flower-heads. *Botanical characters*

A gregarious shrub found throughout the mountain tracts of India, especially at altitudes between 5,000 and 12,000 ft. *Distribution*

The plant is used to prevent moths and other insects from infesting clothes and furniture. It is also used as a symbol of utter calamity, and is frequently mentioned in the Bible. *Uses and properties*

The plant is occasionally used in India and elsewhere for medicinal purposes as an anthelmintic, expectorant, and antiseptic. In larger doses, it causes epileptiform convulsions, profuse sweating with the odour of garlic; violent contractions of uterus, labour-like pains, prolapse and rupture of the uterus, abortion, metorrhagia, and increase of lochial discharges also result from the use of such doses (*8*).

Indian samples have been found to yield an essential oil containing α-thujone, borneol, etc. (*21*).

FIG. 122. *Artemisia vulgaris* Linn.

3. CENTRATHERUM Cass.

(From the Greek *kentron*—a spur, and *antheros*—a flower.)

Botanical characters

Erect or diffusely branched herbs. Leaves petioled, usually toothed. Heads homogamous. Involucre subhemispheric; bracts many-seriate, outer herbaceous, often leafy, inner scarious. Corollas all tubular, equal, purple; lobes 5. Anthers obtusely auricled. Style-arms subulate, puberulous. Achenes obtuse, 8–10-ribbed; pappus scanty or copious, usually short, fugacious.

Distribution

In the tropics.

Centratherum anthelminticum (Willd.) Kuntze

Vernonia anthelmintica Willd., Fl. Brit. Ind., **III**, 236.

(Purple Fleabane)

Vernacular names : ARABIC—Atarilal, Itrilal, Kamune-bari ; BENGAL—Babchi, Bapchi, Buckchi, Bukshi, Hakuch, Kali-ziri, Somraj ; BOMBAY—Kadu-jire, Kadu-karla ; DECCAN—Kala-jira, Kali-jiri, Karvi-ziri ; GUJERATI—Kadvo-jiri, Kali-jiri ; HINDI—Bakchi, Bakshi, Buckshi, Kali-jhiri, Kali-ziri, Somraj, Vapchi ; KANARESE—Kadu-jirige, Kala-jirige, Sahadevi ; KUMAON—Kali-jiri ; MALAYALAM—Kala-jirakam, Kattu-jirakam, Puvankuruntala ; MARATHI—Kala-jira, Kalen-jiri, Kali-jiri, Karalye, Ranacha-jire ; MUNDARI—Kari-giri, Kari-jiri, Kari-juri, Saoraj ; PERSIAN—Atarilal, Itrilal ; PORBANDAR—Kali-jiri ; PUNJAB—Bukoki, Kakshama, Kala-zira, Kali-ziri, Malwa-bakchi, Malwa-bakshi ; SANSKRIT—Aval, Atavijirakaha, Guja, Kanana-jeraka, Rakuchi, Somraji ; SANTAL—Saoraj ; TAMIL—Kattu-chiragam, Sittilai ; TELUGU—Adavi-jilakara, Gariti-kamma, Nelavavili, Vishakantakamulu ; TULU—Kala-jirdari ; URDU—Jangli-jiri ; URIYA—Somraj.

FIG. 123. *Centratherum anthelminticum* (Willd.) Kuntze

Botanical characters

A robust, branched, glandular-pubescent annual 2–3 ft. high. Leaves 3–8 in., membranous, lanceolate or ovate-lanceolate, coarsely serrate. Heads $\frac{1}{2}$–$\frac{3}{4}$ in. diam., subcorymbose. Involucral bracts linear, innermost usually the longest and with purplish tips. Achenes $\frac{1}{5}$ in., narrowed towards the base, 10-ribbed, black, hairy; pappus reddish, outer row of short rigid persistent scales, inner hairs deciduous.

Distribution

Met with throughout India up to an altitude of 5,500 ft. in the Himalayas and Khasia Hills; often cultivated near villages.

Uses and properties

The achenes are reputed in Hindu medicine as a remedy for leucoderma and other skin diseases, and are believed to have anthelmintic properties. They are also used for other medicinal purposes.

In Travancore, the bruised seeds ground up into a paste with lime juice are largely employed for destroying pediculi of the head and body. The plant roasted in a room, or powdered and thrown about the floor, is believed to expel fleas, hence the popular English name (*15*).

Constituents

The bitter principle in the seeds has a weak vermifugal action on ascaris, a somewhat stronger effect on oxyuris, but none on hookworm or tapeworm (*22*).

4. CHRYSANTHEMUM (Tourn.) Linn.

(From the Greek *chrysanthemou*, *chrysos*—gold, and *anthos*—a flower; meaning golden flowers.)

Botanical characters

Herbs, rarely shrubs. Leaves entire, toothed, lobed or pinnatifid. Heads large, terminal, long-peduncled, or smaller and corymbose, heterogamous, rayed; ray-flowers female, 1-seriate, ligule spreading, white, yellow or rosy; disc-flowers 2-sexual, tube terete or 2-winged, limb 4–5-fid. Involucral bracts appressed, many-seriate, inner with scarious tips, outer shorter, often with scarious coloured margins; receptacle naked. Anther-bases obtuse. Style-arms of 2-sexual flowers with truncate penicillate tips. Achenes subterete or angled, variously ribbed or winged; pappus 0 or short, or cupular or auriculate.

Distribution

North temperate regions.

History and uses

This genus (including *Pyrethrum* Hall.) contains 150 species distributed over Europe, Asia, Africa, and America. Of these, *C. indicum* Linn. is the common garden chrysanthemum. A few of the species, *viz.*, *C. cinerariifolium* Vis. (*Pyrethrum cinerariifolium* Trev.), *C. coccineum* Willd. (*C. roseum* Adam, *P. roseum* Bieb.), and *C. marschallii* Aschers. *ex* O. Hoffm. (*P. carneum* Bieb.) have of recent years gained very great importance because of their insecticidal properties. The use of the flower-heads for this purpose apparently originated in Persia where *C. coccineum* and *C. marschallii* were used. About 1840,

C. cinerariifolium was produced in Dalmatia (Yugoslavia), and this rapidly superseded the Persian species. At the present time the Dalmatian pyrethrum is very important from the commercial point of view. In compiling the following note Gnadinger's "Pyrethrum Flowers" (*23*) has been freely used.

The flower-heads are employed either in the form of powder or as a prepared extract. The uses may be broadly divided into 3 groups: (*a*) as household insecticides, (*b*) as livestock sprays, and (*c*) as horticultural dusts and sprays.

(*a*) Pyrethrum is particularly adapted for controlling household insects because it is nonpoisonous to man though to insects its active principles are among the most toxic of substances known. For more than a hundred years, finely powdered pyrethrum has been used to destroy bedbugs, roaches, mosquitoes, and similar insects. The use of such dust for household purposes is, however, not suitable. About 1919 sprays of pyrethrum in mineral oil were commercially offered for household use.

(*b*) The pyrethrum oil spray can be used suitably against flies, which cause considerable annoyance and injury to livestock. The killing power of the sprays is due almost entirely to pyrethrum, though some authorities are of opinion that the mineral oil used may also have some action. Cory, Harns and Anderson (*24*), who investigated the use of pyrethrum dusts for controlling flies on cattle, are of opinion that the impregnated dusts are more effective than sprays.

(*c*) Finely powdered pyrethrum is an excellent horticultural insecticide, but it has now been replaced to a large extent by pyrethrum sprays.

Commercial source of pyrethrum

Till recently Japan and Yugoslavia were the biggest producers of pyrethrum, but of late years Kenya* has assumed a great importance. It is also being grown on a commercial scale in Persia, Algeria, Australia, Brazil, France, Spain, and Switzerland. Owing to an increasing demand, many countries have increased the production of the flower-heads during recent years. Japan, the biggest producer of pyrethrum flower-heads, had increased its production from 3,879,000 lbs in 1920 to 17,763,000 lbs in 1934, and her estimated crop in 1936 was 27,752,800 lbs. Kenya exported to America, her principal buyer, 167,230 lbs during the first nine months of 1936. Because of the higher content

* Since the above was written, pyrethrum cultivation in Kenya has expanded very rapidly. From a total output of only 122,080 lbs of flower-heads in 1934 it has risen to 12,251,456 lbs in 1942 (*62*). Rapid progress is also being made in India where over 156,000 lbs of flower-heads were produced in 1944.

of the active principles, Kenya flowers command a premium of 12 to 15 per cent above the Japanese-grown commodity, and Kenya is thus becoming one of the most important sources of pyrethrum. Yugoslavia produced 1,689,600 lbs of flower-heads in 1934 as compared to 335,000 lbs in 1920.

Possibilities in India

In view of the vast economic possibilities, attempts are being made to cultivate pyrethrum in India. The interest evinced by the Imperial Council of Agricultural Research, Provincial Governments, Indian States, and private individuals is an encouraging feature. Experimental cultivation of pyrethrum flowers has been tried at Baramulla and Tangmarg in Kashmir, Murree Hills, Kulu valley, Palampur, and Kasauli in the Punjab, North-West Frontier Province, Kurrum valley at Parachinar, United Provinces, Bengal, Mysore, and other places. As suggested by Chopra and Badhwar (*25*), the outer temperate Himalayas and hill stations in other areas are likely to prove suitable for the cultivation of pyrethrum in India; and the plant, on the whole, has grown well at altitudes of 5,000 to 6,000 ft. Sustained efforts must, therefore, be directed towards its cultivation in the hills, rather than in the plains. Large areas in the North-West Himalayas, especially in Kashmir, where good quality of pyrethrum could be grown in practically unlimited quantities and where ideal conditions for successful cultivation prevail, are available. Trials may also be made in the Nilgiris, Pulney Hills and in the Eastern Himalayas. It is advisable to avoid areas with heavy rainfall. Cultivation has so far failed at Ranchi, Poona, and in Sind, but failure of germination of its seeds at Kasauli in the Punjab was probably accidental.

Cultivation

In Japan*, when the farm has been suitably prepared, the seedlings are planted in lines at intervals of from 7 inches to 1 ft. between the plants and 1 ft. to 2 ft. between the lines. To prevent stagnant water from gathering round the roots and thereby destroying the seedlings, the rows are raised or ridged. More flowers are obtained if the seedlings are not planted very deep in the earth. There are two seasons for sowing. The spring sowing is carried out in the middle of May and the autumn one towards the end of September. The same idea could be followed in India with local modifications according to the altitude and the degree of cold. For spring sowing the seeds collected in the previous year should be employed, while for autumn sowing those collected during the current year should be used. There is no doubt that old seeds show poor germination.

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* For details of cultivation, harvesting, etc., in Kenya, the reader is referred to a recent mimeographed article by Ball (*62*).

Time of collection

The time of collection is a very important factor. The quality of flower-heads largely depends upon the stage of their growth. As a general rule the flowers of most plants are richer in their active principles prior to, or just before, the time of pollination than in the later stages (*25*).

It has long been accepted that the mature flower-heads are more toxic and consequently closed flowers in 1929 commanded 2 to 3 per cent higher prices per pound. But the average weight of open flowers is about double that of closed flowers, and some recent experiments show that the active principle content in open flower-heads is also more than in the closed ones. Biological tests in other countries have further shown that the correct time to harvest is when the majority of flowers are fully open. It may be pointed out that the weight of flowers goes on increasing as the seeds are formed, but, as is likely and has been corroborated by experiments, the active principle content falls after pollination and fading of the flower-heads, and no useful purpose seems to be served by letting the flower-heads develop seeds.

All these points have to be studied under Indian conditions, and attempts must be made to find out the correlation of the optimum activity of the flower-heads with their highest weight. In this connection it should be borne in mind that experience with numerous plants has shown that adoption of data obtained in other countries is not always wholly applicable to Indian conditions.

Drying

For the sake of convenience, plants are generally dried in the sun. In very many cases this results in a much greater loss of active principles than when the drying is carried out in shade. It has been observed that pyrethrum flower-heads lose a part of their activity by exposure to sunlight, air and heat, and this is more marked in the case of powdered flower-heads. Moisture may also play an important part in this connection. It should also be remembered that the keeping qualities of pyrethrum have been stated to depend upon the stage of maturity at which the flowers were gathered. A careful study of all these points under Indian conditions is of paramount importance.

Active principles and their toxicity

The two active principles of pyrethrum flowers, pyrethrin I and pyrethrin II, are esters of the ketone-alcohol, pyrethrolone, with the two acids chrysanthemum monocarboxylic acid and chrysanthemum dicarboxylic acid methyl ester. The toxicity of pyrethrum is probably due to these esters as no other toxic constituent has been found so far. The amount of pyrethrins in the commercial samples from non-Indian sources, as given by Gnadinger (*23*), usually varies from

0·38 to 1·48 per cent in the case of *C. cinerariifolium*. Figures of analyses carried out by the authors with Indian-grown samples compare very favourably with these figures. Flower-heads of *C. cinerariifolium* from Kashmir showed 0·702 to 1·12 per cent, and of *C. coccineum* from the Murree hills 0·247 per cent. These analyses were done according to the method adopted by Gnadinger and Corl (*23*). It, therefore, appears that the cultivation of *C. cinerariifolium* could be pushed ahead vigorously in India.

Toxicity of pyrethrins

Staudinger and Harder (*26*) have shown that the two pyrethrins do not occur in equal or definite proportions, and this has been confirmed by later workers. Their toxicity to particular insects also varies. Thus, Staudinger and Ruzicka (*27*) found pyrethrin I only slightly more toxic to roaches than pyrethrin II. Gnadinger and Corl (*28*) concluded that pyrethrin II is about 80 per cent as toxic to roaches and house flies as pyrethrin I. Tattersfield, Hobson and Gimingham (*29*) found pyrethrin I about 10 times as toxic to aphids as pyrethrin II. Ripert and Gaudin (*30*) found pyrethrin II more toxic than pyrethrin I to frogs, fish and mice, but the reverse with flies.

Martin and Tattersfield (*31*), Gnadinger and Corl (*32*), and Hartzell and Wilcoxon (*33*) have shown that there is correlation between the total pyrethrin content determined chemically and toxicity to insects, while others have failed to observe such a correlation. In this connection it may be noted that the biological method is affected not only by the insect used for experiment, but also by the method of application, the physical condition of the pyrethrins, and other factors.

More recent investigations of Hartzell and Wilcoxon indicate that the determination of the *total pyrethrin content* is an index of the toxicity of a pyrethrum product at least in the case of pyrethrin oil sprays, and that the determination of pyrethrins I and II separately is not essential. This is also probably true of most horticultural sprays, especially those containing oils (*23*).

KEY TO THE SPECIES

a. Foliage glaucous. Flowers never double . . . 1. *C. cinerariifolium.*
b. Foliage not glaucous. Flowers sometimes double . . 2. *C. coccineum.*

1. Chrysanthemum cinerariifolium Vis.

Pyrethrum cinerariifolium Trev.

(Pyrethrum)

Botanical characters

Glaucous perennial, slender, 12–15 in. high; stems unbranched, with a few short scattered hairs below the flower. Leaves long-petioled,

FIG. 124. *Chrysanthemum cinerariifolium Vis.*

silky beneath, with distant segments. Involucral bracts scarious and whitish at the apex.

Distribution Experimentally* cultivated in some parts of India, especially in the North-West Himalayas.

2. Chrysanthemum coccineum Willd.

C. roseum Adam; *Pyrethrum roseum* Bieb.

(Pyrethrum)

Botanical characters Glabrous perennial, 1–2 ft. high; stem usually unbranched, rarely branched at the top. Leaves thin, dark-green, or in dried specimens dark-brown, not glaucous. Involucral scales with a brown margin. Rays white or red in such shades as pink, carmine, rose, lilac and crimson, sometimes tipped yellow but never wholly yellow. Involucral bracts with a brown margin.—Nearly 700 horticultural varieties have been recognized and given names.

Distribution Experimentally cultivated in Murree and some other places in India.

5. ERIGERON Linn.

(The classical name of a plant allied to groundsel, *Senecio vulgaris* Linn., derived from the Greek *eri*—early, and *geron*—an old man; some species are covered with hoary down when young.)

Botanical characters Herbs. Heads heterogamous, rayed or subdisciform. Ray-flowers white, pink or purple, few-seriate, female, ligule small, very slender; disc-flowers 2-sexual, tubular, yellow, 5-cleft. Involucre hemispheric or campanulate; bracts many, narrow. Receptacle usually naked. Anther-bases obtuse. Style-arms of female flowers linear, of bisexual flowers lanceolate, flattened. Achenes compressed, marginate, narrow, usually minutely villous; pappus often double, the outer row of a few short hairs or bristles.

Distribution Chiefly in temperate regions.

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* Since the above was written, cultivation of this species has made rapid progress in India. According to a conservative estimate, Forest Department of Kashmir State is expected to produce about 224,000 lbs of flower-heads during 1946 and about 448,000 lbs in 1948. The Madras Government are understood to have planted 1,400 acres of land in the Nilgiris. The Baluchistan and Assam Governments, too, have areas under pyrethrum cultivation.

Erigeron canadensis Linn.

Fl. Brit. Ind., III, 254.

(Canada Fleabane, Horseweed)

Vernacular name : KASHMIR—Kach.

Botanical characters

An erect much-branched annual, up to 3 ft. high ; branches very slender. Leaves 1–3 in., narrowly linear or linear-lanceolate, acuminate, entire or remotely toothed. Heads $\frac{1}{6}$–$\frac{1}{4}$ in. diam., peduncled in elongate branched panicles. Ligules pale-rose or purplish. Achenes $\frac{1}{15}$ in., narrow, flat, glabrous ; pappus almost white, turning reddish.

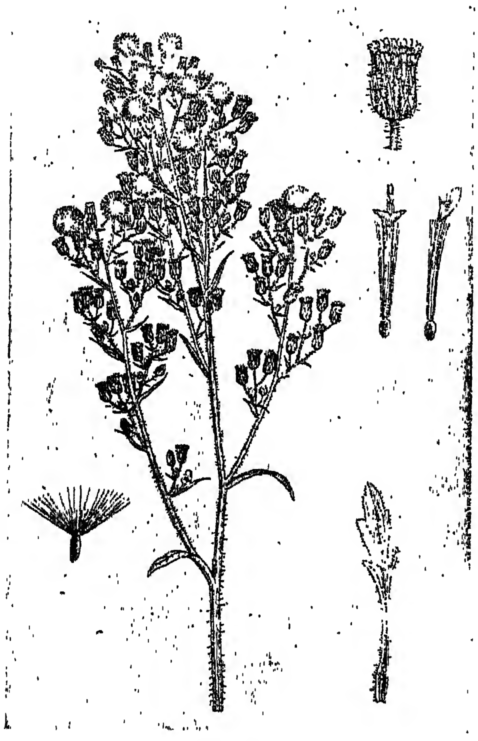

FIG. 125. *Erigeron canadensis* Linn.

Distribution

Found in the Western Himalayas, Punjab, and the Upper Gangetic Plain up to an altitude of 4,000 ft. ; plentiful in certain valleys in Kashmir. It is also found in Shillong (Assam) and on the Western Ghats and Nilgiris up to 6,000 ft.

Uses

This plant is used in Indian medicine as a remedy for diarrhoea, dysentery, and uterine haemorrhage.

Constituents

Fresh leaves contain 0·33 to 0·66 per cent and dry leaves 0·26 per cent (*10*, *34*) of an essential oil known as oleum erigerontis, oleum erigeronis, oil of fleabane, and oil of Canada fleabane. It was at one time included in the United States Pharmacopoeia. The essential oil contains mainly limonene and also dipentene, terpineol and methyl ethyl acetic acid (*35*). Tannic acid and gallic acid have also been isolated from the leaf (*10*).

Toxicity

The oil has an acrid taste and causes smarting of the eyes, soreness of the throat, aching of extremities, and colic. It is stated to produce irritation of the parts of the body coming in contact with the plant. Mixed with hay it may be injurious because the leaves are very bitter and when powdered produce a dust which is irritating (*8*). In the United States of America the plant is stated to cause a mild degree of hay fever, but this is considered doubtful in South Africa (*36*). The action of the herb is probably due to the volatile oil and the tannic acid which it contains. Its effect on animals has not been studied in India. Other species of *Erigeron* are also regarded with much disfavour in America and it is worthy of note that though about 8 species of the genus are found in India, none of them appears to have been observed to be injurious to cattle or man.

6. EUPATORIUM (Tourn.) Linn.

(From the Greek *eupatorion*—hemp agrimony, from *Eupator* –king of Pontus.)

Botanical characters

Herbs, undershrubs or shrubs. Leaves opposite or alternate. Heads corymbose, homogamous. Involucral bracts few- or many-seriate, subequal or outer shorter; receptacle naked. Corollas all equal, regular, tubular; limb 5-lobed or -toothed. Anthers appendaged, base obtuse. Style-arms long, obtuse. Achenes truncate, 5-angled or -ribbed; pappus-hairs many, 1-seriate, rigid, scabrid.

Distribution

Mostly American, a few in Europe, Asia, and tropical Africa.

White snakeroot

White snakeroot (*Eupatorium urticifolium* Linn *f.*) of America is said to produce the disease known as "trembles" in cattle, horses and sheep, and milk sickness in man. The milk sickness in man is caused by consuming the milk or meat of animals who have been eating this plant. Three toxic substances are present, but two of these, a volatile oil and a resin-acid, do not produce trembles in animals. The third, tremetol, is an aromatic straw-coloured oily liquid which is responsible for producing both trembles and milk sickness. The poison is cumulative in character (*37*). The tremetol content of the plant rapidly diminishes on drying (*38*).

Milk sickness

Milk sickness in man and "trembles" in domestic animals are identical. Pasteurization does not destroy the poisonous properties. Trembles appear only in pastured animals. In every outbreak investigated, the animals owing to lack of other means of nourishment had been turned into a wooded area (*39*).

Symptoms in man

The symptoms of milk sickness most commonly described and seemingly characteristic, in order of occurrence, are loss of appetite, weakness or prostration, nausea, persistent vomiting, severe constipation, and epigastric pain. The temperature is characteristically normal or subnormal. Muscular pains are common. There is marked thirst, urine is scanty, acetone is frequently found, and breath has a distinct odour of acetone. Flushed cheeks and undue redness of the lips and tongue are not infrequent. Swelling of the tongue is commonly experienced by the patient. In fatal cases, coma and convulsions precede death. In patients who recover, weakness persists for days, weeks or even months, depending on the initial severity of the illness. Apparently cured patients may relapse if undue physical exertion is practised too soon. In a series of twenty-one patients, two died, and there was a direct relationship between the quantity of milk or milk products consumed and the severity of the disease (*39*).

Symptoms in animals

In animals, according to Marsh and Clawson, as quoted by Muenscher,* the most noticeable symptom is trembling, especially in the muscles about the nose and legs. The trembling may be preceded by a period of depression and inactivity. Most cases of poisoning also result in constipation, nausea, vomiting, quickened and laboured respiration, weakness, and finally inability to stand.

Treatment

In general, treatment consists of saline purgatives, fluids, and alkalis by mouth, dextrose intravenously and enemata. The old remedy of brandy and honey finds some basis in the statement of Hardin, who says: "The administration of alcohol causes an ester of tremetol to be formed which is less toxic. If the patient becomes overheated before the ester is excreted, a hydrolysis of the ester occurs, liberating the poison" (*39*).

Other toxic species

Another foreign species, *E. chinense* Linn., produces a form of chronic poisoning showing necrotic degeneration in the liver and tubular nephritis (*40*). The roots and leaves of the Himalayan *E. cannabinum* Linn. are considered emetic and diuretic; in Indo-China the herb is used as an emmenagogue and purgative. *E. odoratum* Linn., an obnoxious weed introduced from the West Indies, and covering extensive areas in Bengal and Assam, has been recorded as poisonous to fishes.

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* Muenscher: *Poisonous Plants of the United States*, 1939.

Ayapana, *E. triplinerve* Vahl (*E. ayapana* Vent.) of America, is considered a stimulant and tonic, and is planted in Indian gardens.

7. GNAPHALIUM Linn.

(From the Greek *gnaphalion*—soft down; in allusion to the soft downy or woolly covering of the leaves.)

Botanical characters Hoary or woolly herbs. Leaves entire. Heads small, in terminal or axillary corymbs or fascicles, heterogamous, disciform; flowers all fertile; outer female, 2–many-seriate, with filiform, 3–4-toothed corollas; disc-flowers fewer, bisexual, slender, with slightly dilated and 5-toothed corolla-limb. Involucre ovoid or campanulate; bracts many-seriate, all scarious, or with a white, yellow or brown, more or lesss scarious blade. Receptacle naked or pitted. Anther-bases sagittate, cells with slender tails. Style-arms of bisexual flowers truncate or capitate. Achenes oblong or obovoid, not ribbed; pappus-hairs 1-seriate, slender or thickened towards the tip, caducous.

Distribution Cosmopolitan.

Gnaphalium luteo-album Linn.

Fl. Brit. Ind., III, 288.

(Jersey Cudweed)

Vernacular names: BURMA—Byaingchepiu; PUNJAB—Balraksha.

Botanical characters A very variable more or less woolly annual 4–18 in. high, often corymbosely branched above. Leaves 1–2 in. long, sessile, oblong-spathulate, obtuse; upper lanceolate, acute, ½-amplexicaul. Heads leafless, whitish-yellow or brownish, in dense corymbose glistening clusters. Involucral bracts oblong, obtuse, hyaline except the base. Achenes tubercled or with minute curved bristles.

Distribution Found throughout India, ascending in the Himalayas to an altitude of 10,000 ft. Variety *multiceps* (Wall.) Hook. *f.* with golden-yellow heads is the rarer Indian form, while var. *pallidum* (Buch.-Ham.) Hook. *f.* with pale-brown heads is common all over the country.

Uses and properties This plant has apparently been suspected of causing poisoning of livestock in South Africa; but, given in flowering stage by mouth to rabbits, it produces no ill effects (*41*). The leaves of the plant are used in India for medicinal purposes. The flower-stalks of a foreign species, *G. javanicum* Reinw. *ex* Blume, contain 0·05 per cent of an essential oil (*42*).

FIG. 126. *Gnaphalium luteo-album* Linn.

8. INULA Linn.

(The classical name of elecampane, *I. helenium* Linn.)

Herbs, rarely shrubs. Leaves radical and alternate. Heads solitary, corymbose or panicled, heterogamous, rayed, rarely disciform. Ray-flowers female, 1–many-seriate, with yellow or white, 3–4-toothed corollas; disc-flowers bisexual, with tubular, yellow, 5-toothed corollas. Involucral bracts many-seriate, inner usually rigid and narrow, outer herbaceous and outermost often foliaceous. Receptacle pitted or areolate. Anther-bases sagittate; tails long, simple or branched. Style-arms of bisexual flowers linear, broader upwards, obtuse. Achenes usually ribbed; pappus-hairs rather short, 1–2-seriate, smooth, scabrid or bearded. *Botanical characters*

Europe, Asia, and Africa. *Distribution*

Economic and toxic aspects

Besides *I. graveolens* Desf., dealt with hereafter, *I. royleana* DC. occurring in Kashmir is also considered to be poisonous. It is used as an adulterant of 'kuth' root (*Saussurea lappa* C. B. Clarke). The root of elecampane, *I. helenium* Linn. (*non* Hook. *f.* & Thoms.), a foreign plant, contains inulin, the bitter principles pseudo-inulin and inulenin; also 1 to 2 per cent of an essential oil the chief constituent of which is a lactone, called alantolactone (*10*). Besides alantolactone, the roots contain *iso*alantolactone and dihydroalantolactone. Alantolactone has been recently shown to be less toxic than santonin or ascaridole. It is relatively nontoxic to dogs and shows strong anthelmintic action against ascaris (*43*).

Inula graveolens Desf.

Fl. Brit. Ind., III, 292.

Botanical characters

An annual, slender, much-branched herb, 1–2 ft. high, pubescent and viscid. Leaves 1–1½ in. by $\frac{1}{10}$–$\frac{1}{6}$ in., sessile, linear, acute, entire.

FIG. 127. *Inula graveolens* Desf.

Heads $\frac{1}{3}$ in. diam., terminating slender axillary branchlets. Involucral bracts few, linear, acute or acuminate, erect, outer green. Ligules very short. Achenes $\frac{1}{4}$ in. long, hairy and viscid, contracted at the apex with a cup-shaped tip ; pappus-hairs inserted on the edge of the cup.

Distribution

In wastelands in North-Western India.

Uses and properties

This plant does not seem to be used in India in medicine nor for any other purpose, but in Europe it is used as a remedy for colic, dysuria and amenorrhoea, and in Australia for asthma.

It contains a laevorotatory yellowish-green volatile oil from which bornyl acetate (*44*) has been isolated. According to Merck (*45*), preparations of the plant are capable of paralyzing both the respiration and the motor activities of animals. It is stated that the plant apparently contains two principles which act upon the central nervous system. On account of the suspected toxicity of the plant to livestock, a single observation has been made with oral administration of the plant to a rabbit (*41*) ; the results were inconclusive, as the animal died after six days from pneumonia and pleuritis.

9. LACTUCA (Tourn.) Linn.

[The Latin name of the lettuce, *L. scariola* Linn., var. *sativa* (Linn.) C. B. Clarke, derived from *lac, lactis*—milk ; referring to its juice.]

Botanical characters

Herbs with a milky juice. Leaves radical and alternate, cauline often amplexicaul. Heads homogamous, yellow, purple or blue ; flowers all ligulate. Involucre usually narrow ; bracts usually few-seriate, not thickened in fruit, inner slender, subequal, outer often very short ; receptacle flat, naked. Corollas ligulate, truncate, 5-toothed. Anther-bases sagittate, auricles acute or setaceous. Achenes compressed or flattened, beaked, faces ribbed, the middle rib often strongest, beak dilated into a pappiferous disc ; pappus copious, hairs very slender, simple, usually soft and white.

Distribution

Chiefly in north temperate regions.

Economic and toxic aspects

Some of the wild species are credited with hypnotic and poisonous properties, but it appears that their action is uncertain. Blue lettuce [*L. pulchella* (Pursh) DC.] of America is not liked by cattle, and is regarded with suspicion. Wild lettuce of Europe (*L. virosa* Linn.) is considered poisonous. The milky juice which flows out on incision yields on spontaneous evaporation the well-known substance lactucarium, from which extractum lactucae (B. P. C.) is prepared. The dried milky juice of wild lettuce was introduced by Dr. Coxe of Philadelphia in 1799 as a sedative. It had some reputation as a hypnotic in ancient times, but this is probably undeserved (*3*).

Not much is known about the bitter *L. scariola* Linn. of the Western Himalayas and Western Tibet. The cultivated variety *sativa* (Linn.) C. B. Clarke is the lettuce of salads, and yields lactucarium but perhaps not so constantly as the European *L. virosa*.

Lactuca tatarica C. A. Mey., var. tibetica Hook. *f.*

Fl. Brit. Ind., III, 406.

Botanical characters — Glabrous; stem stout, paniculately branched above. Leaves coriaceous; radical and lower sinuate-toothed or runcinate-pinnatifid and sharply toothed. Heads erect, $\frac{3}{4}$ in.; peduncles bracteolate. Achenes narrowly oblong, strongly ribbed, smooth, suddenly contracted beneath the pappus into a very short cylindric beak; pappus twice as long as the achenes, silvery.

Distribution — A common herb at altitudes of 12,000 to 16,000 ft. in Western Tibet.

Toxicity — According to Stewart (*46*), this plant is occasionally browsed upon by sheep, but is said to produce toxic effects at times. The tips of the leaves and their lobes are slightly pungent.

10. SENECIO (Tourn.) Linn.

(From the Latin *senex*—an old man; referring to the white pappus or to the receptacle which is naked and resembles a bald head.)

Botanical characters — Herbs or shrubs. Leaves radical or alternate, entire or cut. Heads usually yellow, solitary, corymbose or racemose, usually heterogamous; ray-flowers female, ligulate (rarely 0); disc-flowers bisexual, with tubular, 5-fid corollas. Involucral bracts 1- or sub-2-seriate, equal, erect, with a few or many very short outer bracteoles. Anther-bases obtuse or auricled or minutely tailed. Style-arms of bisexual flowers recurved, tips truncate and penicillate, rarely rounded or with a short narrow point. Achenes subterete or outer dorsally compressed, 5–10-ribbed; pappus-hairs soft, white, smooth, scabrid or barbellate.

Distribution — Chiefly in temperate climates and mountains of the tropics.

Toxic aspects — The genus *Senecio* is of considerable toxicological importance in some foreign countries, *e.g.*, South Africa, New Zealand and Nova Scotia, especially in the first-named. It has received much attention from chemical and toxicological points of view, and various species have from time to time been regarded as causing disease in man and animals.

Of the species that are implicated in poisoning may be mentioned *Senecio burchellii* DC., *S. latifolius* DC., *S. jacobaea* D. Don, *S. vulgaris*

Linn., etc. The last-mentioned has been introduced into Indian gardens, and there are several escapes. There are, however, about sixty-five species of this genus that are quite common in the mountainous tracts of India, and it is unfortunate that not much is known regarding their toxicity. It is interesting to remark here that none of the senecios has been mentioned by Indian writers as fodder, and so far as the present authors are aware they are not browsed upon by livestock.

Constituents

Several poisonous alkaloids have been isolated from species belonging to this genus, *viz.*, senecifoline, senecifolidine, senecionine, jacobine, squalidine, retrorsine, jacodine, seneciphylline, platyphylline, etc.

Poisoning in man

Cases of chronic poisoning by senecio in man have been recorded, particularly from Riversdale, Cape Province. The symptoms are dyspepsia, abdominal pain, vomiting, and ascites; there is sometimes diarrhoea and gastro-intestinal haemorrhage. A large proportion of the patients die. The poisoning results from the accidental inclusion of the plant with wheat during harvesting and ineffective sieving of the grain during milling (*47*).

Molteno Cattle Sickness

Poisoning in animals

"Molteno cattle sickness" or straining disease in cattle and dunsiekte, stomach staggers, grass staggers, ragwort poisoning, senecio cirrhosis disease or Molteno disease in horses have been ascribed to the eating of senecios.

According to Chase (*48*), affected cattle become "unthrifty" but do not show serious symptoms for some time. A few days before death, the animal develops a most pernicious type of diarrhoea, but it may not be marked. Soon straining commences, which often increases in intensity and frequency, and may be so severe as to produce eversion of the rectum and haemorrhage. A considerable degree of abdominal pain is associated with the diarrhoea and straining. Cattle cease to yield milk. A frenzy sometimes develops, and the animal attempts to charge anyone approaching it. Finally, the affected animal becomes unconscious, and dies in two to four days from the onset of diarrhoea and other definite symptoms.

Chambers (*49*) described the effect of senecio on horses leading to cirrhosis of the liver, and tentatively associated this poisoning with roaring.

Post-mortem appearance

Post mortem, one finds haemorrhagic spots in the fourth stomach and cirrhosis of the liver. The latter organ is small and slaty blue in colour, and the gall-bladder is distended with bile. In some cases the liver does not superficially appear to be much altered, but examined

microscopically it is found to be markedly congested. Petechiae are usually found in the mucosae of the gall-bladder and of the urinary bladder, and in the heart muscle, while there may be inflammation of the small intestine around the openings of the bile ducts (*48*).

Treatment

All authorities agree in the impossibility of cures except in the very early stages. The animal may be kept alive for a few months by careful feeding; but when let out on the veldt the stomach again becomes engorged with grass and the original symptoms reappear.

Senecio vulgaris Linn.

Fl. Brit. Ind., III, 342, without description.

(Groundsel)

Botanical characters

An erect branching annual ½–1 ft. high, glabrous or bearing a little loose, cottony wool. Leaves pinnatifid, embracing the stem, with ovate, toothed or jagged lobes. Flower-heads almost sessile, in close terminal corymbs or clusters. Involucres cylindrical, of about 20 equal bracts, with several outer smaller ones. Florets almost always all tubular, without any ray whatever. Achenes slightly hairy.

Distribution

This is an introduced species in India. Clarke suggests that *S. ramosus* Wall., the Sikkim and Assam plant, may be a tropical form of *S. vulgaris*, but, according to Fl. Br. Ind., the small heads and the involucral bracts and achenes are very different. It is not described by Roxburgh but in the Benthamian Herbarium there is a specimen communicated by that botanist to Dr. Forsyth. Further, according to Fl. Brit. Ind., *S. vulgaris* in Wight's Herbarium from the Nilgiris is no doubt an escape, and Thomson had garden specimens from Moradabad.

Toxicity

Cushney and Watt found that the plant is toxic to animals, resembling *S. jacobaea* D. Don in toxicity and symptoms (*50*).

Two alkaloids have been isolated from the plant, which are designated as senecionine which is crystalline and senecine which is amorphous (*51*). The percentage of senecionine from samples of *S. vulgaris* collected in April, June, and September was 0·015, 0·06, and 0·015, respectively (*52*). The alkaloids, which are also present in *S. jacobaea*, produce in cattle toxic effects resembling those produced by volatile oils. Haemorrhages in abdominal organs, especially the liver, fatty changes, necrosis, congestion and hepatic cirrhosis (*53*, *54*) have been observed. The fluid extract (10 to 20 drops) has been used as an emmenagogue. It has a slight depressant effect on the excised uterus (*55*).

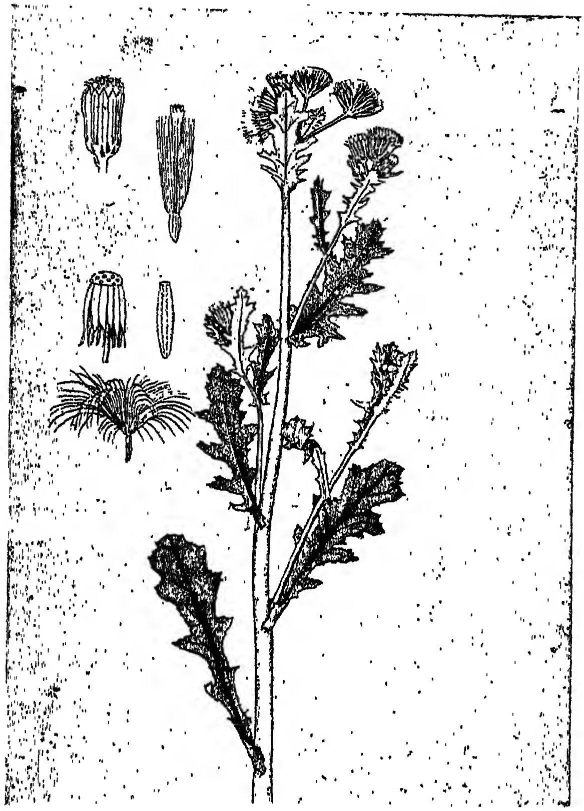

FIG. 128. *Senecio vulgaris* Linn.

11. SPHAERANTHUS Vaill. *ex* Linn.

(From the Greek *sphaira*—a globe, and *anthos*—a flower; referring to the globular shape of the inflorescence.)

Botanical characters

Low annuals with spreading branches. Leaves toothed, decurrent. Heads apparently large but consisting of many small heads sessile on a common receptacle and forming globose or ovoid clusters resembling single heads, clusters usually involucrate. Heads disciform, heterogamous; outer flowers female, with slender, minutely 2–3-toothed corollas; disc-flowers bisexual, solitary or few, with thickened corolla-tube having 4–5-toothed limb. Involucral bracts dry, unequal. Receptacle small, naked. Anther-bases sagittate, auricles acute or tailed. Style-arms of bisexual flowers filiform or connate. Achenes oblong, subcompressed; pappus 0.

Distribution

Tropical Asia, Africa, and Australia.

Sphaeranthus indicus Linn.

Fl. Brit. Ind., III, 275.

Vernacular names: ARABIC—Kamazariyus, Kamdaryus; BENGAL—Chagul-nadi, Ghork-mundi, Murmuriya; CUTCH—Munderi; DECCAN—Mundhri, Mundi; GUJERATI—Bodio-kalara, Gorakha-mundi, Mundi; HINDI—Gorakh-mundi, Mundi; MALAYALAM—Adakka-manian, Attakka-manni, Miran-gani; MARATHI—Barasavodi, Gorakha-mundi; MUNDARI—Ku unara; PERSIAN—Kamaduriyus, Randarummi-talkh; PORBANDAR—Gorakh-mundi: PUNJAB—Ghundi, Guruk-mundi,' Khamadurs, Mundi, Zakhmi-haiyat; SANSKRIT—Mundi, Munditika; SANTAL—Belaunja; TAMIL—Kottak, Karandai; TELUGU—Boda-soram, Boda-tarapu; URDU—Kamdaryus, Mundi; URIYA—Buikadam, Murisa.

Botanical characters

A much-branched, strongly scented, glandular-hairy herb, about 1–2 ft. high; branches ascending, with toothed wings. Leaves 1–2 in. long, sessile, decurrent, obovate-oblong, narrowed to the base, dentate or serrate, the teeth often bristle-pointed. Clusters of heads $\frac{3}{8}$–$\frac{5}{8}$ in. diam., globose or shortly oblong, on winged peduncles. Involucral bracts ciliate at apex. Flowers pink or purple. Achenes stalked.

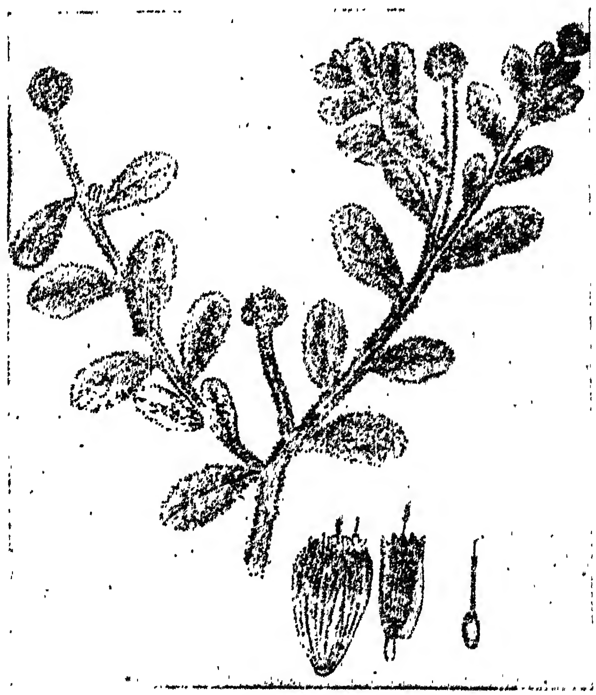

FIG. 129. *Sphaeranthus indicus* Linn.

Distribution

Throughout India, especially in damp places and in cultivated fields after harvest, ascending in the Himalayas up to an altitude of 5,000 ft. from Kumaon to Sikkim.

Uses

This plant is used medicinally as an anthelmintic, stomachic, alterative, aphrodisiac, and depurative in indigenous medicine.

Toxicity

By the Mundas of Chota Nagpur, the whole plant is bruised and thrown into water to kill fish. It is also stuffed into crabs' holes to kill them.

Constituents

The herb contains 0·022 per cent of an essential oil (*56*). It is also stated to contain a bitter alkaloid (*57*).

12. XANTHIUM (Tourn.) Linn.

(From *xanthion*, the Greek name of *Xanthium strumarium* Linn., derived from *xanthos* —yellow; the ancients extracted a dye from the plant.)

Botanical characters

Coarse, rough annuals, unarmed or with 3-fid spines. Leaves toothed or lobed. Heads monoecious (female and 2-sexual—functionally male), axillary; bisexual heads in the upper axils, globose, many-flowered, flowers with 5-toothed corollas; female heads 2-flowered, apetalous. Involucre of 2-sexual heads short; bracts free, 1–2-seriate; receptacle cylindric, with hyaline paleae enclosing the flowers. Involucre of female heads with the bracts united into an ovoid 2-beaked herbaceous 2-celled utricle with one flower in each cell, clothed with hooked bristles and with sometimes a few small free outer bracts. Filaments monadelphous; anthers free, bases obtuse, tips mucronate, inflexed. Style of 2-sexual flowers slender, undivided; style-arms of female flowers free, exserted from the involucre. Achenes enclosed in the hardened involucral cells (like seeds in a capsule), compressed, obovoid, thick; pappus 0.

Distribution

Probably of American origin.

Toxic aspects

Some of the foreign species, *e.g.*, *X. canadense* Mill. (*X. echinatum* Murr.), are stated to be poisonous to animals. *X. strumarium* Linn., which is found in India, has been observed to be poisonous to livestock and pigs in other countries. The involucre of these plants is clothed with hooked bristles and is indigestible; the herbs sometimes injure an animal feeding upon them. It appears, therefore, that in their investigation the question of mechanical injury caused by the eating of these plants should not be lost sight of.

Xanthium strumarium Linn.

Fl. Brit. Ind., **III**, 303.

(Burweed, Cocklebur, Clotbur)

Vernacular names: Assam—Agara; Bengal—Ban-okra; Burma—Cho-sa, Koukpin; Gujerati—Gadriyun; Hindi—Ban-okra, Chhota-datura, Chhota-gokhru, Shankha-huli; Kashmir—Lane-tsuru, Tsur; Marathi—Dumundi, Dutundi, Sankeshvara, Shankeshvar, Shaskeshvar; Punjab—

Chirru, Gudal, Jojre, Kuri, Sungtu, Vangan-tsuru; PUSHTU—Baggaiari; SANSKRIT—Arishta; SIND—Gokhru-kalan; TAMIL—Marulu-muttai; TELUGU—Marula-matangi, Marulu, Parsvapu, Tala-noppi, Talnopi, Verri-tala-noppi.

Botanical characters

A coarse unarmed herb; stem spotted, harsh with bristly hairs. Leaves petioled, scabrid, 2–3 in. long, triangular-cordate, cuneate at the base, coarsely lobed and toothed, strongly 3-nerved. Heads in terminal and axillary racemes. Fruiting involucres $\frac{5}{8}$ in. long, ovoid or oblong, covered with hooked prickles; beaks erect.

FIG. 130. *Xanthium strumarium* Linn.

Distribution

Throughout the hotter parts of India, usually near habitations, ascending in the Western Himalayas up to an altitude of 6,000 ft.

Uses and properties

The leaves of this plant yield a yellow dye. The fruit is used in indigenous medicine as a sudorific, diaphoretic, sedative, and as a sialagogue. The "young flowering-top and the two leaves immediately below,"

boiled in 'khar' water, are eaten by the people of Assam (*vide* "Note on the condition of the people of Assam," App. D). This statement appears to be interesting and requires proper investigation as the plant has been found to be poisonous to cattle and pigs in America and Australia. It is said to paralyze the heart and to produce coma and death without pain or struggle (*15*).

In Australia the young plants are said to be poisonous (*58*), but according to Arthur of Illinois though decoctions may be toxic, the plants are not poisonous to domestic animals under field conditions (*58*).

The plant produces dermatitis in susceptible persons. The authors' plant collector has often suffered from itching and sores through contact with the leaves in pre-fruiting stages of the plant, but he is immune to them when the fruits have matured during autumn. Most persons, however, are not affected by the plant at any stage of its growth.

Zander isolated 1·27 per cent of an amorphous glucoside, xanthostrumarin, from the seeds (*59*). *Constituents*

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Family XLVII.—CAMPANULACEAE

(Bellflower Family)

Botanical characters

Herbs or undershrubs, often with milky juice. Leaves alternate or rarely opposite, simple, exstipulate. Flowers axillary or terminal, solitary, racemose or subpaniculate; bracts small, bracteoles usually 0. Calyx inferior or superior; limb 4–6-partite, usually persistent. Corolla superior, regular or (in the Tribe Lobelieae) irregular, tubular, rotate or campanulate; lobes valvate in bud. Stamens 4–6, inserted on the epigynous disc or rarely on the corolla-tube; anthers free or united in a tube. Ovary 2–5-celled; placentas axile; style 1; stigmas as many as the cells. Fruit capsular or baccate. Seeds many, small, albuminous.

Distribution

Temperate and subtropical regions.

Economic and toxic aspects

Some plants of this family, such as canterbury bells (*Campanula* sp.), are cultivated in gardens for their handsome flowers. Several species of *Lobelia* are more or less poisonous and a few have been used in place of tobacco; the milky juice of some is intensely acrid.

Lobelia inflata Linn. of America was used by American Indians as a substitute for tobacco, and is of interest because of its use in Western medicine. It has been employed in small doses in respiratory affections, especially in chronic emphysema, in spasmodic croup, and spasmodic bronchitis. Poisoning of animals feeding on the herbage of this plant has also been reported. It is a nauseant expectorant and deranges digestion. As an emetic it is effective, but not sufficiently safe. In large doses the symptoms are alarming but rarely dangerous, because emesis, which empties out the stomach before absorption takes place, nearly always occurs. Many of the specimens of the dried plant are, however, almost inactive (*1*). The plant contains the alkaloids lobeline, lobelanine, lobelanidine, *nor*lobelanine (*iso*lobelanine), *nor*lobelanidine, and lobinine (*2*).

Lobeline is the most active of the alkaloids present in lobelia. It paralyzes the ganglia of the involuntary nervous system after a preliminary phase of excitation. It has a curare-like action, but this is seen only in mammals under anaesthesia and artificial respiration (*2*).

Of the several Indian species, *L. nicotianifolia* Heyne is well known and is described in detail later. Of the other Indian species *L. excelsa* Lesch., which is closely allied to *L. nicotianifolia*, has somehow not been given prominence in Indian literature. Its local uses are

just the same as those of *L. nicotianifolia* and, like the latter, it is used as a substitute for tobacco. The milk of both the species is intensely acrid. Watt (*3*), on the authority of Campbell, states that the leaves of *L. trigona* Roxb. are eaten as a potherb in Chota Nagpur.

Constituents The members of this family have been found to contain active *alkaloids*, such as lobeline and the related ones mentioned above.

LOBELIA Plum. *ex* Linn.

(In honour of Matthias de *Lobel*, a Flemish botanist of the sixteenth century.)

Botanical characters Herbs (Indian species), often tall. Leaves toothed, rarely subentire. Flowers on axillary, 1-flowered, sometimes subracemose peduncles. Corolla oblique, 2-lipped; upper lip 2-partite, lower 3-lobed. Staminal tube free or nearly so; 2 or all anthers tipped with bristles. Ovary inferior, 2-celled. Capsule loculicidally 2-valved within the calyx-teeth. Seeds ellipsoid, compressed or trigonous.

Distribution Tropical and temperate regions; rare in Europe and Western Asia.

KEY TO THE SPECIES

a. Leaves softly villous, thick. Racemes softly villous. Anthers glabrous on the back .. .. 1. *L. excelsa.*

b. Leaves glabrescent or sparingly pilose, thin. Racemes pubescent. Anthers more or less hairy on the back .. 2. *L. nicotianifolia.*

1. Lobelia excelsa Lesch.

Fl. Brit. Ind., III, 427.

Botanical characters Resembles closely *L. nicotianifolia* but has softly villous thick leaves, and much denser softly villous racemes of flowers which are pale-yellow tinged with purple. The anthers are glabrous on the back.

Distribution Grows on the Western Ghats of South India, the Nilgiris, Pulney Hills, and hills of Travancore at altitudes of over 6,000 ft.

Uses and properties The leaves of this plant are locally cured and smoked in the same way as tobacco by the poorer classes. The milk is extremely acrid.

2. Lobelia nicotianifolia Heyne

L. nicotianaefolia Heyne. Fl. Brit. Ind., III, 427.

(Wild Tobacco)

Vernacular names: BENGAL—Bada-nala, Nala; BOMBAY—Bokenal, Boknal, Daval, Deonal, Dhaval; CUTCH—Anchi; GUJERATI—Nali; HINDI—Nala, Narasala; KANARESE—Kadahogesoppu, Kandele; MALAYALAM—Kattupukayila; MARATHI—Devanala, Nala, Thora-devanala; TAMIL—Kattuppugaiyailai; TELUGU—Adavi-pogaku; TULU—Katupugeri.

FIG. 131. *Lobelia nicotianifolia* Heyne

Botanical characters

Biennial or perennial herb, 5–12 ft. high; stem hollow, branched upwards. Leaves subsessile, lower often 12 by 2 in., upper gradually smaller, all narrowly obovate-lanceolate, serrulate, sparingly pilose or glabrescent. Flowers large, white, tinged with lilac, in more or less pubescent terminal racemes. Anthers more or less hairy on the back. Seeds compressed, yellowish-brown, extremely acrid.—Often a yellow viscid secretion is found on the peduncles. Odour very disagreeable.

Distribution

Found on the Western Ghats from Bombay to Travancore at altitudes of 3,000 to 7,000 ft.; met with in Konkan, Matheran, the Deccan, Southern Mahratta Country, the Nilgiris, Malabar, Mysore, etc.

Uses and properties

The upper portion of the stem is hollow, and when dried is used as a shepherd's pipe (called "panwa" in the Konkan).

The whole plant, when dry, is studded with small spots of resinous exudation, and it is hot and acrid to the taste. The dust of the powdered herb irritates the nostrils in the same way as tobacco. According to Lisboa, quoted by Watt (*3*), the seeds are preferred to "Datura" as a poison, when rapid effect is desired. In India it appears to be more widely known as a poison than as a drug, though it is used in indigenous medicine as an antiseptic, and as a remedy against asthma and scorpion stings.

Symptoms

The symptoms of poisoning are similar to those of nicotine, except that there is more burning pain in the stomach. Death occurs by paralysis of respiration. Ten to fifteen grains of the powdered leaves or seeds will act as a powerful emetic, and one drachm of the powdered leaves has produced death.

Post-mortem appearance

Post-mortem examination shows inflammation of the stomach and intestines, and congestion of the vessels of the brain (*4*).

Constituents

The leaves contain two alkaloids one of which resembles lobeline from *L. inflata* (*5*).

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Family XLVIII.—ERICACEAE

(Heath and Rhododendron Family)

Botanical characters

Shrubs, trees or perennial herbs. Leaves alternate or apparently whorled; stipules 0. Flowers regular, or in *Rhododendron* sometimes irregular, bracteate and often 2-bracteolate. Calyx usually free, 5-, rarely 4- or 6-lobed. Corolla hypogynous, usually campanulate or urceolate, usually gamopetalous; lobes or petals usually 5. Stamens 10, sometimes 5, 8 or 20, free or attached to the base of corolla; anthers opening by apical pores or slits, the cells often produced upwards in tubes, sometimes dorsally spurred. Ovary 5- (or 4–16-) celled; stigma simple or shortly lobed. Fruit capsular, loculicidal or septicidal, sometimes apparently baccate (*Gaultheria*). Seeds many, albuminous.

Distribution

Cosmopolitan except in deserts and in hot damp tropical regions.

Economic and toxic aspects

Many plants of this family are bitter, astringent and diuretic, others are stimulant and several are poisonous. Some species of *Rhododendron* are frequently cultivated for ornamental purposes all over the world, but in India *R. arboreum* Sm. is the only one that seems to be at all cultivated in some hill stations, and that too very rarely.

The American bearberry (*Arctostaphylos uva-ursi* Spreng.) is a well-known drug used for its diuretic and antiseptic properties in catarrh of the bladder. It contains the glucoside arbutin, tannins, and other constituents. Wintergreen (*Gaultheria procumbens* Linn.), a foreign species, is a small creeping shrub with evergreen leaves and edible fruit. It yields the well-known oil of wintergreen or gaultheria oil, which serves as an aromatic stimulant and is also used externally as a counter-irritant in rheumatism. A similar essential oil is also found in the Indian *G. fragrantissima* Wall.

Several Indian and foreign genera of this family, *e.g.*, *Rhododendron*, *Kalmia*, *Andromeda*, *Lyonia*, etc., contain a highly toxic substance, andromedotoxin, and have caused numerous deaths among livestock all over the world. *Rhododendron campanulatum* D. Don is a serious problem for shepherds in the Himalayas, where scores of deaths due to this plant occur annually among livestock. The leaves of *Pieris ovalifolia* D. Don from the Himalayas and Khasia Hills have produced fatal results in sheep and goats; they are also thought to have insecticidal properties. Among foreign plants, some species of *Kalmia* have caused deaths among cattle and sheep. Some species of *Leucothoe* are also reported to be poisonous, but nothing is known regarding the Indian representative of this genus. Amongst other poisonous plants of this

family may be mentioned species of *Ledum*, some of which are suspected to have toxic properties. *L. palustre* Linn. is stated to be poisonous by Lander (*1*) and Pammel (*2*), but, according to Willis (*3*), it is used as tea in Labrador.

Popular opinion ascribes poisonous properties to the honey from the flowers of *Rhododendron californicum* Hook. (Californian rhododendron) and *R. ponticum* Linn., both of which are foreign plants. It is interesting to note that similar ideas prevail in India with regard to some Indian species of this genus as also *Pieris ovalifolia* D. Don.

Constituents

The members of this family have been found to contain: (*a*) *glucosides*, such as asebotin, gaultherin, arbutin, methylarbutin, ericolin, kalmiin, rhododendrin, etc., (*b*) *toxic substances*, such as andromedotoxin, and (*c*) *essential oils*, such as oil of wintergreen containing about 99 per cent of methyl salicylate, and oil of marsh rosemary containing the toxic substance known as ledum camphor.

KEY TO THE GENERA

A. Capsule loculicidally 5-valved.
- *a*. Calyx in fruit succulent, surrounding the capsule. Anthers with 2 horns on their back .. .. 1. *Gaultheria*.
- *b*. Calyx in fruit unaltered. Flowers racemed. Seeds linear-oblong, not margined .. .. 2. *Pieris*.

B. Capsule septicidal. Anthers opening by terminal pores .. 3. *Rhododendron*.

1. GAULTHERIA Kalm *ex* Linn.

(In honour of M. *Gaulthier*, a Canadian botanist and physician of the eighteenth century.)

Botanical characters

Erect or procumbent shrubs. Leaves evergreen, alternate, serrulate. Flowers small, sometimes dimorphic, racemose or axillary and solitary. Calyx 5-fid, in fruit enlarged, coloured and succulent, enclosing the capsule. Corolla ovoid-tubular, greenish-white or reddish; teeth small, recurved. Stamens 10: filaments pilose; anther-cells more or less produced upwards, dorsally 1 2-horned, simple in dimorphic flowers. Ovary 5-celled; stigma simple. Capsule loculicidally 5-valved from the apex. Seeds subglobose, obtusely angled.

Distribution

Mostly American, a few elsewhere.

Gaultheria fragrantissima Wall.

Fl. Brit. Ind., III, 457.

Vernacular names: LEPCHA—Kalomba; NEPAL—Machino.

Botanical characters

A stout shrub. Leaves 3 by 1-1½ in., lanceolate to ovate, shortly acute or subobtuse, rhomboid at base, crenate-serrate, coriaceous,

punctate below. Flowers white or greenish, closely placed in dense, more or less pubescent racemes 1–3 in. long. Anther-cells each with 2 terminal bristles. Fruit $\frac{1}{5}$ in. diam., brown, hairy, surrounded by the deep-blue succulent calyx.

FIG. 132. *Gaultheria fragrantissima* Wall.

Distribution

Found from Nepal to Bhutan at altitudes of 6,000 to 8,000 ft.; also on the Khasia Hills, Western Ghats, the Nilgiris, the Pulneys, and hills of Travancore at altitudes of over 5,000 ft.

Uses and properties

The fruit of this plant is stated to be edible. The oil of wintergreen which is so commonly used in medicine as an external application for rheumatic affections, sciatica, neuralgia, etc., and which is also used as a flavouring agent in tooth pastes, is obtained by distilling the leaves and sometimes the whole herb of *G. procumbens* Linn., a plant indigenous to the United States of America. A similar oil is obtained in large quantities from *Betula lenta* Linn. (the sweet birch)

and has also been discovered in many plants of the families Cupuliferae, Rosaceae, Polygalaceae, Ericaceae, Leguminosae, and others. Puran Singh studied the distillation products of the Indian *G. fragrantissima* and found that only the Assam plants contained sufficient oil for commercial purposes. He obtained 1·2 per cent of the oil from the dried plant and 0·65 per cent from the fresh plant with 99·14 per cent of methyl salicylate (*4*). The herb from the Nilgiris gave 0·12 to 0·23 per cent of the essential oil during winter. The properties of the Indian oil have been found to be very similar to those obtained in other countries (*5*).

The oil contains about 99 per cent of methyl salicylate ; it acts somewhat more slowly, but otherwise quite as efficiently as sodium salicylate, the toxic dose being about two thirds of the sodium salt. The effects may be considerably delayed, suggesting slow and irregular absorption (*6*). It is given internally in capsules, and is used externally as a counterirritant.

Poisoning

Fatal poisoning by methyl salicylate is rare, but has been reported, especially from its use as an abortifacient. One-ounce dose is usually fatal, producing gastritis, severe congestion of the kidneys, convulsions, coma, and death. Rosenbloom and Johnston (*7*) report severe poisoning caused by one-ounce dose, but ending in recovery ; there was immediate emesis followed by severe salicylism and albuminuria, both of which persisted for a couple of weeks.

2. PIERIS D. Don

(From *Pieria*, a district of Macedonia ; the supposed abode of the Muses.)

Botanical characters

Trees or shrubs. Leaves alternate, evergreen. Racemes axillary or panicled at the ends of the branches. Calyx 5-fid or -partite. Corolla ovoid ; lobes 5, short, recurved. Stamens 10 ; filaments with 2 horns divaricate from its apex. Ovary 5-celled ; stigma capitellate. Capsule globose, loculicidally 5-valved. Seeds linear-oblong, falcate, not winged.

Distribution

The Himalayas, Burma, Japan, North America.

Pieris ovalifolia D. Don

Fl. Brit. Ind., III, 460.

Vernacular names: Bushahr—Erau, Ladrang, Yerta ; Bhutia—Piazay ; Garhwal—Angyar ; Hindi—Ayar, Anyar ; Jaunsar—Anyar, Ayar ; Kumaon—Ayar ; Lepcha—Kangshior ; Nepal—Aigiri, Angiar, Anjir, Jagguchal ; Punjab—Ailan, Aira, Arur, Arvan, Ayatta, Bhel, Eilan, Eilaur, Ellal, Erau, Erana, Piru, Ratankath, Sarlakhtei, Yarta.

A small deciduous tree. Leaves $2\frac{1}{2}$–6 by 1–3 in., ovate or elliptic, acute or acuminate, entire, rounded at base, coriaceous. Flowers $\frac{1}{3}$–$\frac{2}{5}$ in. long, white, in simple terminal and axillary racemes 1–4 in. long. Calyx-teeth triangular-lanceolate. Corolla slightly pubescent without. Capsule $\frac{1}{5}$ in. diam., globose. *Botanic characters*

FIG. 133. *Pieris ovalifolia* D. Don

Found in the outer Himalayas from the Indus eastwards, usually at altitudes of 3,000 to 8,000 ft.; common east of the Ravi and in Khasia Hills between altitudes of 3,000 to 5,000 ft. *Distribution*

According to Stewart (*8*), the young leaves and buds are poisonous to goats in the spring months only. They are said to produce cerebral symptoms which can be cured by administering 'lassi' (butter milk) to the affected animals. Inquiries made by the authors in Jammu confirm the observation cited above and, according to local information, the leaves are not eaten by cattle. Madden, quoted by Watt (*9*), states that honey collected from the flowers of this plant is poisonous. The young leaves are considered to have insecticidal properties, and the smoke of the burning wood is said to cause inflammation of the eyes and the face. *Toxicity*

It is said to contain the toxic substance andromedotoxin (*10*). *Constituents*

3. RHODODENDRON Linn.

(From the Greek *rhodon*—a rose, and *dendron*—a tree.)

Botanical characters

Trees or shrubs; often scaly or aromatic. Leaves alternate, often clustered towards the ends of branches, entire, coriaceous. Flowers fascicled or subcorymbose, terminal, rarely solitary or axillary. Calyx 5-lobed, persistent, sometimes small or obsolete. Corolla campanulate, widely funnel-shaped or cylindric, 5–10-lobed, somewhat irregular. Stamens 5-18, usually 10; anthers dehiscing by terminal pores. Ovary 5–20-celled; stigma capitate. Capsule short and woody or elongate and thinner, septicidally 4–20-valved, valves breaking away from the placentas. Seeds often shortly crested, or tailed.

Distribution.

Mountain tracts of Europe, Asia, Malaya, and North America.

Toxic aspects

There are about 45 species of this genus in India, but the poisonous properties of only a few of them are known. It is likely that several more may possess toxic properties. *R. campanulatum* D. Don from the Himalayas is a serious menace to livestock, especially in early spring when fodder is scarce at high altitudes.

Andromedotoxin, a nitrogen-free neutral substance, has been isolated from some species. This substance seems to belong to the veratrine group so far as its physiological action is concerned, and the symptoms produced resemble those of aconite poisoning (*11*). Andromedotoxin is extremely poisonous, even more so than aconitine, and is more powerfully emetic than emetine (*2*). The seat of the emetic action of the poison has not been determined. The increased secretion of saliva is probably only the first stage of the emetic action, and is not due to a specific effect upon the salivary glands or their secretory nerves. It acts upon the terminations of the vagii which are at first stimulated and then paralyzed. It paralyzes the motor nerve endings in striped muscles; involuntary muscles not supplied by the vagii are not affected. It has a narcotic effect upon the higher centres in the brain, but does not affect the spinal cord. In very large doses death is produced by direct action on the heart, while with smaller doses it is the failure of respiration which causes death. The poison has a slight vasoconstrictor effect of peripheral origin upon the blood vessels. Injected hypodermically, at least one-third of the poison leaves the body unchanged in the urine (*12*).

Poisoning in animals

After ingestion of rhododendron leaves, cattle and sheep manifest intense pain, diarrhoea and discomfort, gritting the teeth, salivation, and frequently vomiting. There is suppression of lactation, trembling and spasms, vertigo, loss of power, and death (*1*).

In horses (*13*), there is marked salivation, incessant attempts to vomit, bulging and bloodshot eyes, quick respiration, staggering gait,

extreme coldness of the body and extremities, and cold sweats. The animal becomes practically pulseless.

Post-mortem appearance. This is not well marked (*1*).

Treatment

A brisk oleaginous purgative, followed by chlorodyne or counter-irritants to allay abdominal pain, general stimulants, and tonics are indicated in cases of poisoning (*1*).

Aromatic rhododendrons

The aromatic rhododendrons, *e.g.*, *R. anthopogon* D. Don and *R setosum* D. Don of the alpine Himalayas are regarded by the Bhutias to produce headache and nausea in people ascending to high elevations. Furthermore, the leaves of the former are considered as errhine, as they produce sneezing.

KEY TO THE SPECIES

A. Leaves beneath glabrous or tomentose, without glandular scales.

I. Calyx-lobes small or obsolete.

a. Corolla-lobes 7–10. Stamens 12–16 .. 5. *R. falconeri*.

b. Corolla-lobes 5. Stamens 10.

aa. A tree. Leaves lanceolate or oblong, narrowed at both ends, silvery beneath 1. *R. arboreum*.

bb. A shrub. Leaves elliptic, subobtuse at both ends, with cinnamon-coloured tomentum beneath .. .. 3. *R. campanulatum*.

II. Calyx-lobes large, elliptic. Leaves oblong, glabrous, midrib beneath and petiole often coarsely bristly .. 2. *R. barbatum*.

B. Leaves sprinkled beneath with sessile round glandular scales. Calyx very shortly or obsoletely lobed .. 4. *R. cinnabarinum*.

1. Rhododendron arboreum Sm.

Fl. Brit. Ind., III, 465.

Vernacular names*: ALMORA—Brons; BUSHAHR—Bras, Shrak; BHUTIA—Etok; BURMA—Zalatni; CHAMBA—Cheu; GARHWAL—Burans; HAZARA—Chahan, Chhan; JAUNSAR—Burans; KUMAON—Bras, Brus; LEPCHA—Etok; MALAYALAM—Kattu-puvarasu; NEPAL—Bhorans, Ghonas, Gurangs, Guras, Lal-guras, Taggu; NILGIRIS—Billi, Pumaram; PUNJAB—Ardawal, Aru, Bras, Broa, Chacheon, Chiu, Mandal; TAMIL—Alingi, Billi; TRANS-INDUS—Trikhgandere; WESTERN HIMALAYAS—Brons, Burans, Chiu.

Botanical characters

An evergreen tree. Leaves crowded towards the ends of branches, 3–6 by $1\frac{1}{5}$–$2\frac{2}{5}$ in., lanceolate or oblong, narrowed at both ends, glabrous above, silvery beneath. Flowers 1–2 in. long, red, occasionally pink or spotted, rarely white, crowded in large rounded corymbs. Calyx-teeth unequal, about $\frac{1}{10}$ in. long. Corolla campanulate, 5-lobed. Stamens 10. Capsule 1 by $\frac{1}{3}$ in., cylindric, curved, mealy, longitudinally ribbed.

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* The South Indian vernacular names refer to *R. nilagiricum* Zenk (*R. arboreum* Sm., var. *nilagirica* C. B. Clarke).

Distribution

Common in the temperate Himalayas from the Indus to Bhutan between altitudes of 4,000 to 11,000 ft., in Khasia Hills between 4,000 to 6,000 ft., and also in Manipur. The South Indian plant, treated as var. *nilagirica* in the Fl. Br. Ind., is described as *R. nilagiricum* Zenk. by Gamble in the " Flora of the Presidency of Madras "; it is found in open grasslands in the Western Ghats, the Nilgiris, the Pulneys, and hills of Travancore above 5,000 ft. in altitude.

Toxicity

Madden, quoted by Stewart (*8*), states that the young leaves of this species are extremely poisonous. The honey collected by the wild bee at its flowering time is believed in Sikkim to be poisonous.

The flowers have a sweetish-sour taste and are said to make a good subacid jelly. In some parts of the Himalayas, they are eaten by the local people, who, according to Madden, become intoxicated if they consume them in large quantities.

Constituents

The plant is poisonous and probably contains the glucoside ericolin (*14*).

2. Rhododendron barbatum Wall. *ex* G. Don

Fl. Brit. Ind., III, 468.

Vernacular names : BHUTIA—Kemu ; NEPAL—Chimal, Guras.

Botanical characters

A tree, 30–40 ft. Leaves 6 by $1\frac{1}{2}$–2 in., oblong, acute, base rounded, reticulated beneath, glabrous, the midrib beneath and petiole often coarsely bristly. Heads many-flowered, dense. Calyx-lobes $\frac{1}{4}$ by $\frac{1}{8}$ in., elliptic. Corolla deep-red, 1–$1\frac{1}{2}$ in. wide, funnel-shaped. Stamens 10. Capsule $\frac{3}{4}$ by $\frac{1}{4}$ in., hirsute.

Distribution

Found in the temperate Himalayas from Kumaon to Bhutan at altitudes of 8,000 to 12,000 ft. ; common in Sikkim.

Toxicity

The plant is mentioned by Chopra (*5*) as a fish poison.

Constituents

It contains the toxic substance andromedotoxin (*10*).

3. Rhododendron campanulatum D. Don

Fl. Brit. Ind., III, 466.

Vernacular names : BUSHAHR—Simrang ; GARHWAL—Chimura, Semru, Simris ; HINDI—Cherailu ; KASHMIR—Gaggar, Yurmi, Ner ; KULU—Shargar ; KUMAON—Chimul ; NEPAL—Cheraidhu, Cheriala, Nilochimal, Teotosa ; PUNJAB—Sarngar, Shargar, Shinvala, Simrung ; TEHRI-GARHWAL—Simris ; TIBET—Bargi ; UNITED PROVINCES—Chimul.

Botanical characters

An evergreen gregarious shrub. Leaves crowded towards the ends of the branches, 3-5 by $1\frac{3}{4}$–$2\frac{1}{2}$ in., elliptic or elliptic-oblong, rounded at both ends, mucronate, glabrous above, clothed beneath with a dense cinnamon-coloured tomentum which conceals the nerves. Flowers 1–$1\frac{1}{2}$

FIG. 134. *Rhododendron campanulatum* D. Don.

in. long, lilac, pale-purple or whitish-pink, in lax corymbs. Calyx-teeth very small, broadly triangular. Corolla companulate, 5-lobed. Stamens 10. Ovary glabrous or nearly so. Capsule $\frac{3}{4}$–$1\frac{1}{2}$ by $\frac{1}{4}$–$\frac{1}{3}$ in., cylindric, more or less curved, longitudinally furrowed.

Distribution

Found in the outer and inner ranges of the Himalayas from Kashmir to Bhutan at altitudes of 9,000 to 14,000 ft., usually in gregarious patches.

Uses

The leaves of the plant mixed with tobacco are used in indigenous medicine as a remedy for rheumatism, sciatica, and in the form of snuff against colds and hemicrania. The wood makes good fuel, but the smoke is very acrid and irritant.

Toxicity

The attention of the authors has been drawn during their tours in the Western Himalayas to the poisonous effects of this plant on goats and cattle. During summer the shepherds and cowherds in the Punjab usually take their flocks to hills for grazing purposes. These animals, as a rule, do not eat the plant but cases have occurred, especially during the time of scarcity of fodder in early spring, when the animals have browsed upon this plant with fatal results. Almost every cowherd has had unfortunate experiences with this plant and dreads it. Often a large number of the plants are rooted out and thrown down the mountain sides by the local people in the hope of doing their little bit towards the extermination of this pest, but the problem is not so simple. The poisonous properties of this plant do not appear to have been recorded by earlier writers in India.

Constituents

A specimen of the leaves was obtained from Kashmir and analyzed. A toxic substance was isolated, whose chemical and pharmacological properties resembled closely those of andromedotoxin (*15*).

4. Rhododendron cinnabarinum Hook. *f.*

Fl. Brit. Ind., **III**, 474.

Vernacular names: Lepcha—Keehung, Kema; Nepal—Balu, Sanuchimal.

Botanical characters

A shrub, 4–8 ft. Leaves 2–3 by 1–$1\frac{3}{4}$ in., oblong or elliptic, acute or obtuse, glabrous, beneath mealy white or cinnamoneous with scattered glandular scales. Flowers orange, rose or brick-red or scarlet. Calyx-lobes small, unequal or obsolete. Corolla $1\frac{1}{4}$ by $\frac{1}{3}$ in., pendulous, campanulate; lobes ovate. Stamens 10; filaments pilose at base. Ovary 5-celled, glandular-scaly. Capsule $\frac{1}{3}$–$\frac{1}{2}$ by $\frac{1}{4}$ in. Seeds ovoid or trigonous, hardly produced at all.

Distribution

Found on the slopes of the Eastern Himalayas in Sikkim and Bhutan at altitudes of 10,000 to 12,000 ft.

The leaves of this species are universally considered poisonous to cattle and goats. The wood is employed as a fuel, but the smoke produces inflammation of the eyes and causes the face to swell up (*16*). *Toxicity*

It contains the toxic substance andromedotoxin (*10*). *Constituents*

5. Rhododendron falconeri Hook. *f.*

Fl. Brit. Ind., **III**, 465.

Vernacular names : BHUTIA—Kalma, Kegu ; NEPAL—Kurlinga.

A tree about 30 ft. high ; frequently a large gregarious shrub. Leaves 9 by 3–4 in., elliptic, obtuse, obtuse or subcordate at base, rugose by impressed nerves above, ferruginous-tomentose beneath ; petiole $\frac{3}{4}$–$1\frac{1}{2}$ in. Flowers in many-flowered dense heads. Calyx subobsolete. Corolla 1–2 by $\frac{3}{4}$–$1\frac{1}{2}$ in., white or yellowish with purple spots at the base within, 7–10-lobed. Stamens 12–16. Capsule 1–2 by $\frac{1}{2}$–1 in., more or less tomentose and curved. Seeds ellipsoid, compressed, margined. *Botanical characters*

Common in the Himalayas from East Nepal to Bhutan at altitudes of 9,000 to 13,000 ft. *Distribution*

Chopra (*5*) mentions the plant as a fish poison. *Toxicity*

It contains the toxic substance andromedotoxin (*10*). *Constituents*

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Family XLIX.—PLUMBAGINACEAE

(Plumbago Family)

Botanical characters

Herbs, undershrubs or shrubs. Leaves alternate, the radical usually rosulate; stipules 0. Flowers pentamerous, bracteate. Calyx inferior, gamosepalous, tubular or funnel-shaped, 5–10-ribbed. Corolla hypogynous, gamopetalous, salver-shaped or the petals almost free. Stamens opposite the corolla-lobes or petals, adnate to the base of the corolla. Ovary free, 1-celled, 5-angular above; ovule 1, suspended from a long basal funicle; styles 5, free or more or less connate. Capsule membranous or with a hardened apex, included in the calyx. Seeds cylindric.

Distribution

Throughout the world, mostly in maritime or saline situations.

Economic and toxic aspects

Members of this family possess bitter, tonic, and astringent properties; occasionally they are acrid and caustic. Some of the plants are grown in gardens, and of these may be mentioned the rosy-flowered leadwort (*Plumbago indica* Linn., syn. *P. rosea* Linn.) and white-flowered leadwort (*P. zeylanica* Linn.). The roots of both these species are acrid and produce vesication when bruised and applied to the skin. *P. capensis* Thunb. from South Africa, with pale-blue flowers and subverticillate leaves, is another garden plant.

Acantholimon lycopodioides Boiss. is a densely tufted prickly shrub forming rounded cushion-like masses, and is one of the few characteristic plants of North Kashmir and Western Tibet at altitudes of 11,000 to 14,000 ft.

Constituents

Plumbagin, a napthaquinone derivative, is the only toxic substance so far isolated from plants of this family; it is found in *Plumbago indica*, *P. zeylanica*, and some other species of *Plumbago*.

PLUMBAGO Tourn. *ex* Linn.

(The Latin name of *P. europaea* Linn., used by Pliny, derived from *plumbum*—lead; the plant is stated by him as efficacious in curing lead poisoning.)

Botanical characters

Herbs or undershrubs, sometimes scandent. Leaves alternate, entire. Flowers in terminal spikes, white, rose or blue. Calyx tubular, covered with stalked glands; limb 5-fid. Corolla-tube long, slender; lobes 5, round, spreading. Stamens free. Style slender, divided above into 5 stigmatose branches. Capsule circumsciss near the base, hardened above.

Distribution

In warmer regions of the world.

Roy and Dutt (*1*) have found that plumbagin is present in *P. indica* Linn. (*P. rosea* Linn.) and *P. zeylanica* Linn. to a maximum of about 0·9 to 1 per cent, and that its proportion varies within wide limits according to the locality, growth, age, condition of the soil, and season of the year. These workers found that the older the plant and drier the soil, the greater was the quantity of this active principle present in its roots. It has also been found that fresh roots yield a much greater proportion of plumbagin than roots which have been stored for a considerable time. *Toxic aspects*

Keien Ko (*2*), who studied the pharmacological action of plumbagin, found that it stimulates the central nervous system in small doses, while with larger doses paralysis sets in, leading ultimately to death. The blood pressure shows a slight fall and the peripheral vessels are found to dilate. The stimulant action is not properly observed in the isolated heart of the frog. Small doses stimulate the plain muscles all over the body, but large doses produce immediate paralysis. The minimum lethal dose has been found to be 0·5 mgm per gm for frog, 0·1 mgm per gm for mice, and 10 mgm per kgm for rabbits. Bhatia and Lall (*3*) have studied *P. zeylanica* and state : (*a*) The active principle is plumbagin and the pharmacological action of the plant is due to the presence of this substance. (*b*) Externally it is markedly irritant and has a powerful germicidal action on bacteria and unicellular organisms. (*c*) The principal action of plumbagin is on the muscular tissue which it stimulates in smaller doses and paralyzes in larger ones. (*d*) It stimulates the contraction of the muscular tissue of the heart, intestines, and uterus. (*e*) It stimulates the secretion of sweat, urine, and bile. (*f*) It has also stimulant action on the nervous systems.

KEY TO THE SPECIES

a. Flowers red. Rachis of the spike glabrous. Base of style hairy .. .. 1. *P. indica*.

b. Flowers white. Rachis of the spike glandular. Base of style glabrous .. .. 2. *P. zeylanica*.

1. Plumbago indica Linn.

P. rosea Linn., Fl. Brit. Ind., **III**, 481.

(Fire Plant, Officinal Leadwort, Rosy-flowered Leadwort)

Vernacular names : ARABIC—Chittermul, Shitaraje-ahmar, Shitturrije ; BENGAL—Chitra, Lal-chita, Rakto-chita, Rakto-chitra ; BOMBAY—Lal-chitra ; BURMA—Chuvondakoduvalli, Kan-chop-ni, Ken-khyoke-ni, Kin-khen-ni ; CENTRAL PROVINCES—Chitrak ; DECCAN—Lal-chitarmul, Lal-chitarmulam ; GUJERATI—Lal-chitrak, Rato-chatro ; HINDI—Chitra, Lal-chita, Lal-chitarak, Lal-chitra, Rakta-chitra ; KANARESE—Kempu-chitramula ; KASHMIR—Shitranj, Shitray ; MALAYALAM—Chentikotuveli, Chettikotuveli, Chukannakotuveli, C.ı vannakotuveli, Shettikodivali ; MARATHI—Lal-chitra, Tambada-chitramula ; PERSIAN—Shitarake-surkh ; SANSKRIT—Aruna-chitraka,

Chitraka, Rakta-chitraka, Rakta-shikha; TAMIL—Akkini, Chittira-mulam, Sengkodiveli, Senkoduveli, Segappukodiveli: TELUGU—Erra-chitramulam, Yerra-chitra; TULU—Kempu-chitramula: URIYA—Lal-chita, Ronga-chitamulo.

Botanical characters

This plant resembles *P. zeylanica* Linn., and is perhaps only a cultivated variety of it. It can easily be distinguished from the latter by its red flowers. The leaves are elliptic, tapering to the short petiole, and the rachis of the spike is glabrous. The base of the style is hairy.

Distribution

Largely cultivated in gardens and has been stated to occur in a state of nature in the Bengal Duars, Sikkim, and Khasia Hills; also found as an escape in South India.

Uses and properties

The root has been mentioned by ancient Sanskrit and Mohammedan writers as an abortifacient and vesicant. It has the reputation of being an appetizer, and of being effective against leucoderma and other skin diseases; it is also used against piles and scorpion stings.

The bruised roots are acrid, and when applied to the skin cause vesication. Taken internally in large doses, it acts as a narcotic or as an irritant poison, and for this latter purpose it is said to be not infrequently employed in Bengal. Chevers (*4*) refers to two fatal cases in which it was so employed, one of them a case of homicide. More commonly, however, the roots are used in India for producing abortion. With this end in view it is sometimes given internally, and has been more than once detected as plumbagin in pills stated to have been administered for this purpose. Usually, however, it is employed as a local-irritant application to the *os uteri*, a portion of the scraped root or twig of the plant being pushed into the vagina, and sometimes even into the uterus. In other cases the end of an abortion stick is covered with cotton wool and smeared with a paste made from the powdered roots. In one case at least a lump of such paste was simply thrust into the upper portion of the vagina, and was found there after death (*5*). Death not infrequently results from the introduction of this highly acrid agent if used in any of the above ways. It is also used as an irritant to the skin by malingerers or in support of false charges. O'Shaughnessy (*6*) found that the root-bark rubbed into a paste with water and a little flour and applied to the skin raised blisters within 12 to 18 hours and that it could be used as a cheap substitute for cantharides. Dymock (*7*) confirms Waring in the latter's conclusions that the resulting blisters were less uniform, caused more pain than the blisters, and did not always easily heal.

Constituents

The root-bark contains the toxic substance plumbagin but there is no alkaloid (*8*). Plumbagin is very irritating and acts freely on mucous membrane. It is 2-methyl-5-hydroxy-1 : 4-naphthaquinone (*9*).

2. Plumbago zeylanica Linn.

Fl. Brit. Ind., III, 480.

(White-flowered Leadwort)

Vernacular names: ARABIC—Shitaraj; BENGAL—Chita, Chitra, Chitruk-sufaid: BOMBAY—Chitra, Chitrak; BURMA—Kanchop-phiju, Kin-khen-phiu; DECCAN—Chitarmul, Chitar-mulam; GUJERATI—Chitaro, Chitrak, Chitro, Gholo-chitro: HINDI—Chita, Chitarak, Chitavar, Chiti, Chitra; KANARESE—Chitramula, Chitramulike, Mulike, Vahni; MALAYALAM—Kotuveli, Tumpa-kotuveli: MARATHI—Chitraka, Chitramula; MUNDARI—Chitur; NEPAL—Chitu; PERSIAN—Bighbarindch, Shitarak, Shitirah: PUNJAB— Chitrak; SANSKRIT—Agnishikha, Chitraka; TAMIL—Adigarradi, Akkini, Angodiveli, Chittira, Chittra-mulam, Kanilam, Kanilindiran, Karimai, Kodiveli, Koduveli, Sadaveda, Sittragam, Sittramulam, Tigana, Vanama, Vellaikkodiveli, Ven-chittiramulam, Ven-godiveli; TELUGU—Agnimata, Chitramulam, Tella-chitramulam; URDU—Chitalakri; URIYA—Chita, Chitamul-nil, Chitamulo, Chitaparu, Krisanu, Ogni.

An undershrub with rambling branches. Leaves $1\frac{1}{2}$–4 in., ovate-acute, suddenly narrowed into a short amplexicaul petiole with a dilated *Botanical characters*

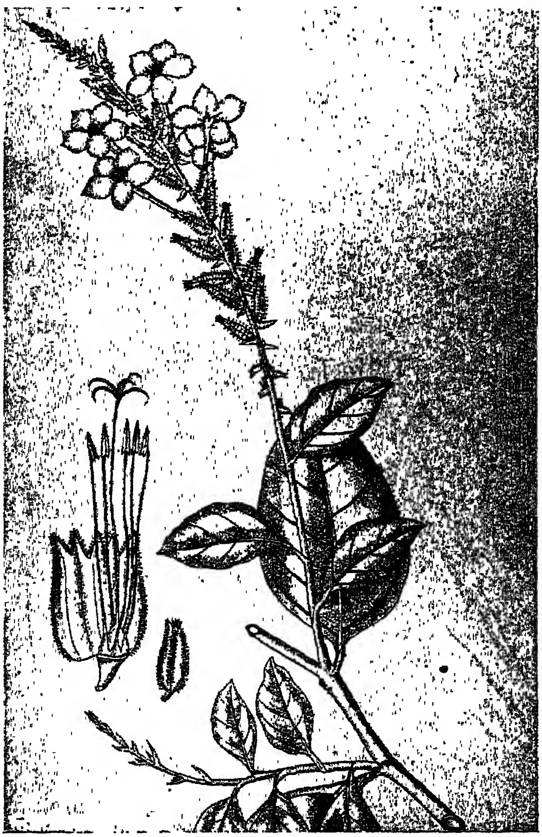

FIG. 135. *Plumbago zeylanica* Linn.

base. Spikes 4–12 in., often branched, the rachis glandular. Flowers $\frac{1}{2}$–$\frac{3}{4}$ in. diam., long-tubed, white. Calyx with conspicuous stalked viscid glands. Base of style glabrous.

Distribution

Largely cultivated in gardens throughout India and often seen as an escape ; grows wild in South India and probably also in Bengal.

Uses and properties

The root is used in indigenous medicine to improve digestion and to promote appetite. It is also used in piles, anascara, diarrhoea, and skin diseases. It possesses similar properties to those of *P. indica* Linn., and both are used for the same purposes.

Constituents

The roots contain plumbagin, but this is absent in the leaves and stems (*1*).

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Family L.—PRIMULACEAE

(Primrose Family)

Botanical characters

Herbs. Leaves radical or cauline, exstipulate. Flowers regular. Calyx inferior (except *Samolus*); 5- rarely 4–9-cleft. Corolla usually hypogynous (0 in *Glaux*), rotate, bell- or funnel-shaped, usually 5-cleft. Stamens on the corolla-tube, opposite its lobes, with sometimes alternating stamiodes. Ovary 1-celled; style short or long; stigma undivided; ovules many, on a free central placenta. Capsule dehiscing by valves or circumsciss, few- or many-seeded. Seeds miute, albuminous.

Distribution

Cosmopolitan; chiefly in north temperate and alpine regions.

Economic and toxic aspects

This family is not important from the economic point of view and none of its members is known to be edible except perhaps *Lysimachia candida* Lindl. which grows in rice fields in the valley of Manipur at altitudes of 2,000 to 3,000 ft. The statement by Watt (*1*) that this plant is regularly used as a vegetable is of considerable interest. Some species of *Primula* (primrose) are cultivated in the gardens of hill stations.

The hairs of the leaves of *Primula obconica* Hance of China and Burma have long been known to set up cutaneous irritation. The typical dermatitis produced by the plant, in sensitive people, is attributed to the substance primin, which it contains (*2*). *P. reticulata* Wall. of India is said to be poisonous to cattle. Scarlet pimpernel (*Anagallis arvensis* Linn.) is found more or less throughout India, and is considered poisonous in this country as well as abroad. It contains the glucosidic saponin cyclamin, which has also been reported from the foreign *Cyclamen europaeum* Linn. (sowbread) and *C. persicum* Mill. *C. persicum* is recorded as a fish poison, and is imported into India for use in medicine as an emetic, emmenagogue, and purgative.

Constituents

The members of this family have been found to contain: (*a*) *glucosides*, such as cyclamin, primulaverin, primverin, etc., (*b*) *saponins*, such as those found in the genera *Primula*, *Anagallis*, *Lysimachia*, etc., and (*c*) *poisonous substances*, such as primin, etc.

KEY TO THE GENERA

a. Capsule circumsciss. Corolla rotate, 5-partite; lobes contorted .. .. 1. *Anagallis*.

b. Capsule dehiscing by valves. Corolla funnel- or salver-shaped; tube long; lobes imbricate .. .. 2. *Primula*.

1. ANAGALLIS (Tourn.) Linn.

(The classical name of pimpernel, *A. arvensis* Linn., probably from the Greek *ana*—again, and *agallo*—to adorn; some species are grown as ornamental plants in gardens.)

Botanical characters Slender herbs. Leaves opposite, entire, dotted. Flowers solitary, axillary, ebracteate. Calyx 5-partite. Corolla rotate, 5-partite, the lobes contorted. Stamens 5, attached to the base of the corolla; filaments villous. Capsule globose, circumsciss. Seeds peltate.

Distribution Europe, Asia, Africa, South America.

Anagallis arvensis Linn.

Fl. Brit. Ind., **III**, 506.

(Blue Pimpernel, Pimpernel, Poor-man's-weatherglass, Scarlet Pimpernel)

Vernacular names: ARABIC—Anadhasira, Anaghalis, Marijaneh, Patijaneha; GUJERATI—Golophudi, Kariphudi; HINDI—Jangmani, Jonkmari; PERSIAN—Anadhasira, Anaghalis, Marijaneh, Patijaneha; PUNJAB—Dhabbar; UNITED PROVINCES—Joinghani, Jonkhmari; URDU—Anaghalis.

Botanical characters An erect or procumbent annual, branching from the base; branches 4-angled. Leaves opposite, sessile, up to 1 in. long, ovate or lanceolate cordate, acute, gland-dotted. Flowers $\frac{1}{3}$–$\frac{1}{2}$ in. diam., blue or scarlet

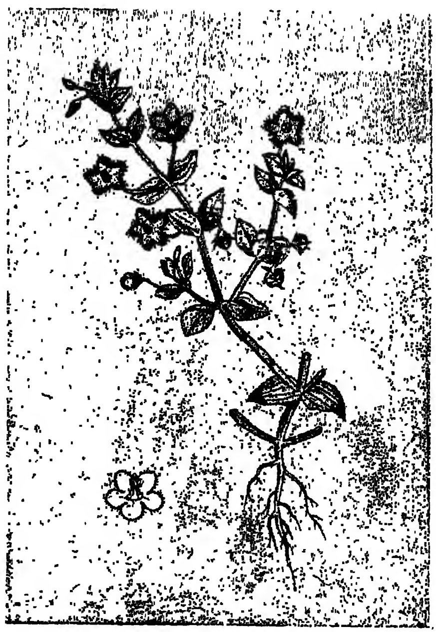

FIG. 136. *Anagallis arvensis* Linn.

closing in dull weather, on 1–2 in. long peduncles which are erect in flower but decurved in fruit. Capsule $\frac{1}{5}$ in. diam., with persistent style.

Distribution

Found over the greater part of India, ascending to an altitude of 8,000 ft. in the Himalayas. The red-flowered variety is found in Kashmir, but the blue-flowered one is more common in India.

Uses and properties

In indigenous medicine, this plant has the reputation of being useful in gout and dropsy and as a remedy for snake bite; it is also used in India to intoxicate fish and to expel leeches from the nostrils of livestock.

It has a bitterish and somewhat acrid taste and is poisonous, producing gastro-enteritis in the dog and horse (*3*).

According to Hyams, quoted by Pammel (*4*), the fluid extract in doses of 4 drachms is fatal to dogs.

Pullar (*5*) reports deaths among sheep grazing on this plant in Australia. As a result of feeding experiments he thinks that the amount of toxic principles present in the scarlet pimpernel varies from time to time and that the plant is toxic for limited periods only and under certain unknown conditions. Pullar also concludes that there appears to be no loss of toxicity after drying the plant. His experiments show that 22 oz of the plant fed in 2 days are enough to kill a sheep.

Symptoms

The symptoms noticed by Pullar among sheep are: "General depression, with head hanging down and ears drooping, anorexia, suspension of rumination, polydipsia and diarrhoea. Respirations were increased in frequency, but breathing was not particularly laboured."

Post-mortem appearance

In the two sheep which died under Pullar's experiments, the following *post-mortem* appearance was noted: "Lungs congested, liver very pale and friable. Kidneys small, pale and marked with groups of small diffuse haemorrhages arranged like leopard markings. In one case there was a small haemorrhage on the ventral cusp of the auriculo-venticular valve of the left heart; in the other case sub-endocardial haemorrhages were present in the left heart. Fat necrosis was noted in the omentum, pericardial and perirenal fat, and a few small haemorrhages were present on the peritoneal surface of the rumen. The mucous membrane of the abomasum was congested, but not ulcerated. In both cases a small slit-like rupture was present in the wall of this organ, but as there was no evidence of peritonitis and no spread of gastric contents through the peritoneum it was considered that this was an agonal lesion."

Constituents

Heintzelman (*6*) isolated from it a pungent, acrid, volatile oil with a peculiar odour, which when administered internally produced intense

headache and nausea, lasting for 24 hours, accompanied by pains throughout the body. The herb (*7*) contains two glucosidic saponins while the root contains cyclamin, which is also a glucosidic saponin. Cyclamin isolated from *Cyclamen europaeum* Linn. (foreign species) is highly toxic (*7*, *8*).

2. PRIMULA Linn.

(From the Latin *primus*—first; referring to the early flowering of many species.)

Botanical characters

Perennial scapigerous herbs. Flowers umbelled or whorled, rarely solitary, often dimorphic (with stamens low and stigma high in the corolla tube and *vice versa*). Calyx 5-lobed. Corolla funnel- or salver-shaped; throat naked or with folds opposite the lobes (annulate); tube long, lobes 5, spreading or incurved, imbricate. Stamens 5, included, anthers obtuse. Capsule globose, oblong or cylindric, 5-valved; valves simple or 2-fid.

Distribution

Chiefly in hilly districts of Northern Hemisphere.

Primula reticulata Wall.

Fl. Brit. Ind., III, 483.

Vernacular names : KUMAON—Bishkopra, Jal-kutra.

Botanical characters

A perennial scapigerous herb, glabrous, slightly mealy or not. Leaves 2–3 in. long, oblong-cordate, obtuse, crenate or doubly crenate, reticuate, glaucous beneath; petiole 4–6 in. Scapes 12–16 in. Bracts large, regularly placed but unequal in size, linear-oblong or lanceolate. Flowers nodding, slightly fragrant. Calyx-lobes short, acute, recurved. Corolla yellow; tube funnel-shaped, much exserted, nearly $\frac{1}{2}$ in.; lobes erecto-patent, small, rounded or notched; mouth naked.

Distribution

Found in the Central and Eastern Himalayas at altitudes of 11,000 to 15,000 ft.

Uses and properties

According to Atkinson, quoted by Watt (1), this plant is poisonous to cattle. It is used externally as an anodyne.

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Family LI.—MYRSINACEAE

(Myrsine and Ardisia Family)

Small trees or shrubs. Leaves alternate, usually gland-dotted; stipules 0. Flowers small, regular, 2-sexual or polygamo-dioecious. Calyx inferior (in *Maesa* more or less superior), 4–6-, usually 5-lobed, persistent, sometimes accrescent. Corolla usually gamopetalous, rotate (rarely campanulate or tubular); segments 3–7, usually 5. Stamens 3–7, opposite the corolla-lobes; anthers sometimes connate. Ovary free (in *Maesa* ½-inferior), 1-celled; stigma simple, rarely shortly lobed; ovules few or many, on a free central placenta. Fruit usually small and globose, often subbaccate and coloured, 1- or many-seeded. Seeds mostly globose, excavate at the base, albuminous. *Botanical characters*

Tropical and subtropical regions. *Distribution*

This family is not important from the economic point of view. Some of the plants belonging to it are used in indigenous medicine for refrigerant, febrifugal, anthelmintic, and laxative purposes. The seeds of 'wawrung' or 'baibrang' (*Embelia ribes* Burm. *f.* and *E. tsjeriam-cottam* A.DC.—syn. *E. robusta* Fl. Brit. Ind., in part, *non* Roxb.) are extensively employed as an adulterant for black pepper in India. Fruits of *Myrsine africana* Linn. and *M. capitellata* Wall. are eaten by poorer people of the localities where they grow. Some foreign species of *Aegiceras* and *Jacquinia* are used as fish poisons. *Maesa indica* Wall. is said to be used as a fish poison in India. *Economic and toxic aspects*

The bark and seeds of *Aegiceras corniculatum* (Linn.) Blanco (*A. majus* Gaertn.) of India contain saponins (*1*), which have also been found in some other plants of the family, *e.g.*, in the leaves and bark of the foreign plant *Maesa pyrifolia* Miq.

MAESA Forsk.

(From *maas*, the Arabic name of one of the species.)

Trees or shrubs. Leaves entire or serrate. Flowers bracteate and 2-bracteolate, white, 1–2-sexual, 4–5-merous, in axillary and terminal racemes. Calyx ½-inferior or nearly free, in fruit ½-adnate; teeth small. Corolla campanulate; lobes round, imbricate, sometimes unequal. Stamens on the corolla-tube; filaments short. Ovary partially adnate to the calyx. Berry globose. Seeds numerous, subtrapezoid. *Botanical characters*

Tropics except America. *Distribution*

Maesa indica Wall.*

Fl. Brit. Ind., III, 509.

Vernacular names: BENGAL—Ramjani; BOMBAY—Atki; GARHWAL—Gadchiana, Jiundali; KANARESE—Gudde-bargi, Mandane, Tanipele: KUMAON—Kalsis, Nagapadhera: LEPCHA—Purmo; MALAYALAM—Kiriti; MARATHI—Atki; NEPAL—Bilauni; TAMIL—Vamarai.

Botanical characters

A large much-branched shrub; twigs markedly lenticellate. Leaves 3-6 by $1\frac{1}{2}$-3 in., ovate-oblong or elliptic-lanceolate, acute or acuminate, serrate-dentate, glabrous and shining above, glabrous or nearly so beneath. Flowers very small, in simple or compound axillary racemes 1-3 in. long. Corolla white, marked with coloured lines. Berry globose, about $\frac{1}{8}$ in. diam., creamy-white, covered almost to the apex by the persistent calyx and tipped with the short style.

FIG. 137. *Maesa indica* Wall.

* Mez has split up this species of the Fl. Brit. Ind. into several smaller species with much restricted distribution (*Das Pflanzenreich*, Heft 9).

Distribution

Found throughout India up to an altitude of 6,000 ft.; common in the North-East Himalayas, Eastern Bengal, Darjeeling district, Manipur, Kanara, and along the Ghats.

Uses and properties

The berries of this plant are considered to have anthelmintic properties; they are stated to be eaten in Nepal. According to Brandis, the leaves are used as a fish poison in Kanara (*2*), and, according to Talbot (*3*), they are used as an ingredient for curries in North Kanara. Cooke (*4*) states that the fruit is used as a fish poison.

Constituents

The leaves and bark of a foreign species, *M. pyrifolia* Miq., contain a saponin (*5*).

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Family LII.—SAPOTACEAE

(Sapodilla and Mahua Family)

Botanical characters

Trees or shrubs, usually with milky juice, young parts often rusty-tomentose. Leaves alternate, coriaceous, entire; stipules 0 or caducous. Flowers 2-sexual, small or medium-sized, axillary; pedicels clustered, rarely solitary or panicled; bracts and bracteoles 0 or minute. Calyx-lobes 4–8, imbricate, or 2-seriate with the outer series valvate, persistent. Corolla-tube shorter than the calyx; lobes as many or 2–4 times as many as the calyx-lobes. Stamens on the corolla-tube, as many as the corolla-lobes and opposite to them, or 2–3 times as many, 1–3-seriate; filaments short; connective often produced; staminodes (when present) alternating with the stamens. Ovary superior, sessile, 2–8-celled; stigma a point; ovules solitary in each cell, axile. Berry 1–8-seeded. Seeds ellipsoid or compressed, shining; hilum long.

Distribution

Tropical regions.

Economic and toxic aspects

This family contains a number of plants of economic importance. Sapodilla plum (*Achras zapota* Linn.) is cultivated throughout India for its edible fruit, which has a pink flesh and brownish epicarp. The resinous latex (chicle gum) of this tree is used in the manufacture of chewing gum. Seeds of the Indian butter tree [*Madhuca butyracea* (Roxb.) Macbride, syn. *Bassia butyracea* Roxb.] yield the vegetable oil known as 'phulwa'. It is used as a substitute for ghee and as an adulterant of the same. Seeds of the mahua tree [*Madhuca latifolia* (Roxb.) Macbride, syn. *Bassia latifolia* Roxb.] and mahua tree of South India [*Madhuca longifolia* (Linn.) Macbride, syn. *Bassia longifolia* Linn.] also yield a vegetable oil; their succulent flowers are used as an article of food and as a material for the manufacture of country spirit. The 'maulsari' tree (*Mimusops elengi* Linn.) grows wild and is also cultivated, chiefly for its ornamental appearance and fragrant flowers. These are valued for making garlands and the 'attar' or otto distilled from them is greatly esteemed as a perfume. The reddish-yellow berries of 'khirni' [*Manilkara hexandra* (Roxb.) Dubard, syn. *Mimusops hexandra* Roxb.] are eaten, especially by the poor. They are, however, powerfully astringent and have poor food value. Gutta-percha, which is used in surgical dressings, etc., is prepared from the latex of some plants of this family, especially from that of the exotic *Dichopsis gutta* Benth. & Hook. *f.* and *Payena leerii* Kurz. *Dichopsis elliptica* Benth. & Hook. *f.*, a large tree of Western Ghats, yields the Indian gutta-percha or 'pala' gum.

In general the bark of plants of this family is bitter, astringent, and antiperiodic. The juice is slightly bitter and acrid.

A fair quantity of a toxic sapo-glucoside, mowrin, has been isolated from the seeds of *Madhuca longifolia*. Leaves of *M. latifolia* contain saponin and traces of an alkaloid ; the seeds also contain a saponin, but it is different from that occurring in the leaves. Both these plants have insecticidal and piscicidal properties. The powdered cake left after the expression of the oil from the seeds is known as "mowrah meal", which is used as a worm killer for lawns.

Saponins have also been reported from some species belonging to the genera *Achras, Mimusops, Baillonella, Lucuma, Dumoria, Dichopsis, Payena,* etc. Glucosides, such as sapotin and arganin, with strong haemolytic action, have also been reported from the seeds of *Achras zapota* Linn. and the exotic *Argania sideroxylon* Roem. & Schult., respectively.

Hydrocyanic acid has been reported as a constituent of two foreign species, *Lucuma salicifolia* H. B. & K. and *Payena latifolia* Burck (*1*).

MADHUCA Gmelin (*Bassia* Koen. *non* All.) *

(From the Sanskrit *madhuka*, from *madhu*—sweet, honey ; the honey-filled flowers of some species are used for food and in preparing an intoxicating drink.)

Botanical character

Trees. Leaves clustered at the ends of branchlets ; stipules caducous. Flowers fascicled, axillary or from the axils of fallen leaves, often nodding. Calyx-lobes 4, 2-seriate, 2 outer valvate enclosing the inner (in *M. butyracea* 5, imbricate). Corolla campanulate, lobed ½-way down ; lobes 6–12 (usually 8–10), contorted in bud. Stamens 12–40 (usually 16–20) ; staminodes 0. Ovary villous ; cells 4–12, usually 6 or 8. Berry globose or oblong-ellipsoid, 1–3- (rarely 4–5-) seeded. Seed exalbuminous.

Distribution

Indo-Malaya, Australia.

KEY TO THE SPECIES

a. Pedicels rusty-tomentose. Anthers 20–30 in 3 series, acuminate.. .. .. 1. *M. latifolia.*

b. Pedicels glabrous. Anthers 16–20 in 2 series, tips 3-toothed .. .. 2. *M. longifolia.*

* *Bassia* Koenig (1771) is invalidated by *Bassia* Allioni (1766), the latter genus (Chenopodiaceae) having been reinstated by several botanists as valid. *Illipe* was not published by Koenig as a generic name, as was considered by Baillon and by Engler, but merely as a native name of *Bassia longifolia* Linn. *Madhuca* Gmelin is the oldest valid name for the genus.

1. Madhuca latifolia (Roxb.) Macbride

Bassia latifolia Roxb., Fl. Brit. Ind., III, 544.

(Butter Tree, Mahua Tree, Mahwa Tree, Mohwa Tree)

Vernacular names: BENGAL—Ban-mahuva, Kochra, Mahua, Mahul, Mahula, Mahwa, Maul; BHIL—Mahura; BOMBAY—Mahua, Mhova, Moha, Mova; BURMA—Kansan; CENTRAL PROVINCES—Mohwa; DECCAN—Jangli-moha, Moha; GOND—Irhu, Irrip, Irup; GUJERATI—Mahuda, Mahura; HINDI—Jangli-moha, Jangli-mohva, Mahua, Mahula, Mahwa, Maul, Mohwa, Mowa; KANARESE—Doddippe, Halippa, Haltumbri, Hippe, Hogne, Hunage, Ippaya, Ippe, Ippi, Kadippe, Kadu-ippe, Oodlu, Pokka, Sonedarakele, Udlu; KHOND—Irpi; KOLAMI—Kuindi, Madkom, Mandukam, Mankadum; KONKANI—Mohwa; KUMAON—Mahwa, Mohwa; MALAYALAM—Irippa, Irippapu, Kattirippa, Pu, Puvuna; MARATHI—Maha, Mahwa, Mhowra, Moho, Mohwa, Mora, Mowda, Mowha, Ranacha-ippecha-jhada, Ranacha-moha-cha-jhada; MUNDARI—Madukam, Mandukamdaru; OUDH—Jangli-moha, Jangli-mohva, Mahua, Mahula, Mahwa, Maul, Mowa; PERSIAN—Darakhte-gulchakane-sahrai, Gule-chakan; PUNJAB—Mohwa, Mehwa; SANSKRIT—Atavi-madhuka, Madhuka; SANTAL—Matkom; SURAT—Mahura; TAMIL—Elupa, Illipe, Illuppai, Kat-illipi, Kat-iluppai, Kattu-irrupai; TELUGU—Adavi-yippa, Ippa, Ippi, Madhukamu, Pedda-yippa, Yeppa; TULU—Ippe, Navildu; URAN—Madgi; URDU—Mahuva; URIYA—Mahul, Moha, Moholo, Mohuka, Mohulo.

Botanical characters

A large deciduous tree with a close symmetrical head. Leaves 5–9 in. long, coriaceous, elliptic or oblong-elliptic, shortly accuminate, base rounded or acute; main nerves 10–14 pairs. Flowers in clusters near the ends of the branches; pedicels 1–1½ in. long, drooping, rusty-tomentose. Calyx densely tomentose. Corolla cream-coloured; tube fleshy; lobes erect. Stamens 20–30, 3-seriate; anthers subsessile; acuminate. Berry 1–2 in. long, fleshy, ovoid, greenish, 1–4-seeded.

Distribution

Found in Dehra Dun and on the Saharanpur Siwaliks, Oudh, Bihar, Chota Nagpur, Orissa, the Central Provinces, Central India, Gujerat, Konkan, North Kanara, Southern Mahratta Country, Northern Circars, and the Deccan; largely planted in other parts and liable to run wild. It is apparently not wild in the Punjab, though, as it has been a long time since it was introduced, it is apt to be taken as such in Kangra. It thrives on dry stony soil.

Uses and properties

The tree is valued for its flowers, fruits, seeds, and timber. The oil extracted from the kernels of the fruit is largely used in the Central and South India for culinary and lighting purposes, and as an adulterant of ghee. It is also used in the manufacture of soap and candles. The fruit is sometimes eaten, but chiefly it is the succulent flowers (corollas), which are eaten raw or cooked or made into sweetmeats. A case of dangerous vomiting with cerebral symptoms caused by eating an excessive quantity of these flowers is on record. In indigenous medicine the flowers are considered as astringent, tonic, and appetizing. The bark is also used as an astringent and as a tonic.

After steeping the flowers in water and allowing them to ferment, a spirit is distilled, which is largely consumed by the inhabitants of the mountainous tracts of the tablelands of Central India. These flowers are considered to be a good and cheap raw material for the manufacture of alcohol, and are now being extensively used for its production on a large scale in Bihar, Orissa, Bombay Presidency, and Bengal.

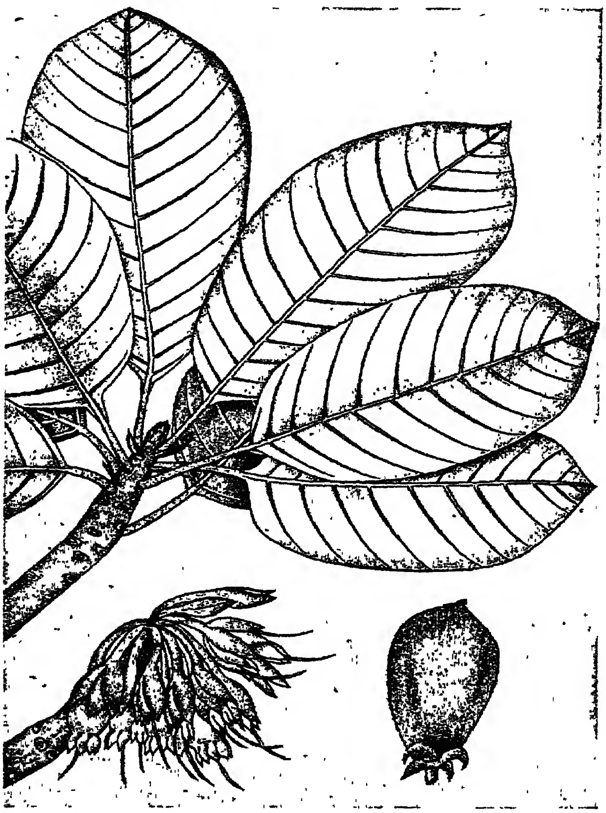

FIG. 138. *Madhuca latifolia* (Roxb.) Macbride

According to the Pharmacopoeia of India, " the SPIRIT distilled from the flowers has a strong smoky odour, somewhat resembling Irish whisky, and rather a pungent fœtid flavour, which, however, disappears with age. The freshly-distilled spirit proves very deleterious, exciting gastric irritation and other unpleasant effects." " It is evidently a powerful diffusible stimulant, and when matured by age may be used as such, when brandy and other agents of the same class are not available " (*2*).

As mentioned above a yellowish-green oil is extracted from the kernel of the fruit to the extent of 50 to 55 per cent. The residual cake, "mowrah meal", is said to be used to poison fish and as a detergent. The smoke produced from the burning of the cake is reputed to kill insects and rats, but this appears doubtful although the statement is made by many writers. The cake is, however, used as a worm killer (*3*) for lawns (4 oz per sq yd).

Constituent

The air-dried cotyledons of the seeds contain 9·5 per cent of a neutral saponin (*4*). The leaves contain a glucosidic saponin, different from that found in the seeds, and also traces of an alkaloid (*5*).

2. Madhuca longifolia (Linn.) Macbride

Bassia longifolia Linn., Fl. Brit. Ind., III, 544.

(Mahwa, Mohwa or Mahua Tree of South India)

Vernacular names: BENGAL—Mahua, Mohuva; BOMBAY—Mhova, Mahwa, Mohi; BURMA—Kanso, Kan-zannu, Meze; CUTCH—Mahuda; DECCAN—Moha; GUJERATI—Mahuda, Mova; HINDI—Moha, Mohua; KANARESE—Hippe, Huli, Ippe, Ippi, Movaro, Sannayippe; KONKANI—Moi; MALAYALAM—Ellupi, Irippa; MARATHI—Ippi, Moha, Mohwa; PERSIAN—Darakhte-gulchakan; SANSKRIT—Madhuka; TAMIL—Elupa, Illipe, Illupi, Illuppai, Iruppai, Kuligam, Kulisam, Madugam, Maduragam, Mavagam, Nattiluppai, Seyilam, Tittinam; TELUGU—Ippa, Ippe-chettu, Ippi, Pinna-ippa, Sanna-yippa, Uri-yippa; TULU—Ippe.

Botanical characters

A large tree. Leaves 3–5 in. long, thin, linear-lanceolate, acute, much tapered towards the base; main nerves 10–12 pairs. Flowers in dense clusters near the ends of branches; pedicels $1\frac{1}{2}$–$2\frac{1}{2}$ in. long, erect at first, afterwards more or less drooping, glabrous. Calyx densely rusty-pubescent. Corolla-tube fleshy, glabrous. Stamens 16–20, 2-seriate; anthers subsessile, 3-toothed at the apex. Berry oblong, the size of a plum, hirsute when young, ultimately nearly glabrous, yellowish when ripe, 1–2-seeded.

Distribution

Found in the forests of Western India from Konkan southwards to Travancore; common in Kanara, Malabar, Mysore, Anamalais, and the Circars at low elevations.

Uses and properties

The properties and uses of this plant are practically the same as those of the preceding species. The bark and flowers are used in indigenous medicine as astringent; the flowers are considered anthelmintic and are also used in the treatment of snake bite.

The seeds contain about 40 to 60 per cent of a fatty oil called "bassia oil". The residual cake, "mowrah meal", is employed as a worm killer for lawns as in the case of *M. latifolia* (*3*). After the oil is extracted, a sapo-glucoside called mowrin is obtained from the residue. This has been isolated as a pale-yellow powder soluble in all proportions in

water and in methyl and ethyl alcohols. This sapo-glucoside is very toxic and workers with mowrah meal sometimes suffer from severe cellulitis of the hands and feet. It has haemolytic action and its action on the heart resembles the drugs of the digitalis group (*6*).

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Family LIII.—EBENACEAE

(Ebony Family)

Botanical characters

Trees or shrubs; wood usually hard. Leaves alternate, rarely subopposite, entire, usually coriaceous, exstipulate. Flowers axillary, cymose or solitary, usually dioecious, 3–7-merous, usually bracteate; pedicels articulated under the flower. Calyx gamosepalous, often accrescent in fruit. Corolla gamopetalous, often hairy outside. Stamens inserted at the base of the corolla, 1–2–3 times as many as the corolla-lobes, free or filaments paired or variously united; staminodes present in the female flowers or 0. Ovary superior, sessile, 2–16-celled; ovules 1–2 in each cell, pendulous; styles 2–8, free or connate into a 2–8-fid style. Fruit coriaceous or fleshy, 1–several-seeded. Seeds compressed, albuminous.

Distribution

Tropical regions, especially Indo-Malaya.

Economic and toxic aspects

This family is of great economic importance, with many species yielding valuable timber. *Diospyros ebenum* Koen. (ebony) is a large tree of the Peninsular India and Assam, much prized for its hard black wood. *D. melanoxylon* Roxb. (Coromandel ebony) of Central Provinces, Bihar, and Peninsular India is another tree of great value on account of its timber and its leaves which are used for making 'biri' (Indian crude cigarettes). *D. discolor* Willd. (mabolo fruit, sometimes called mangosteen) is a small tree with large quince-like fruits having an agreeable taste and pleasant flavour. It has been introduced from the Philippine Islands, and is cultivated in Indian gardens. *D. kaki* Linn. *f.* (sometimes called the Chinese fig and plum or the keg fig of Japan) is a native of Upper Assam, and is cultivated for the sake of its fruit; this is about the size of a small apple and has a delicious taste. *D. virginiana* Linn. has for its fruit the date plum or persimmon of Japan, and is occasionally cultivated in Northern India for its delicious fruit. It is very closely allied to *D. kaki* Linn. *f.*

In general, the barks of plants belonging to this family are considered to be bitter, astringent, and febrifuge; the unripe fruit is a powerful astringent. *Diospyros montana* Roxb., *D. ebenum* Koen., and *D. paniculata* Dalz. are used as fish poisons.

DIOSPYROS Linn.

(An old Greek name used by Theophrastus, from *dios*—divine, and *puros*—wheat, *i.e.*, celestial food.)

Botanical characters

Trees, rarely shrubs. Flowers green, white or yellowish, usually in small cymes, females often solitary, 4–5- rarely 3-merous. Calyx often

deeply lobed. Corolla tubular, salver-shaped or campanulate; lobes twisted to the right. Male flowers: Stamens 4–64, often 16; filaments free, paired or otherwise united. Ovary rudimentary. Female flowers: Staminodes 0–16. Ovary 4–5- or 8–10-celled; cells 1- (rarely 2-) ovuled; styles or style-branches 1–4. Fruit globose, ellipsoid, or ovoid-conic, often supported by the much enlarged and sometimes woody calyx; flesh often pulpose or viscid.

Mostly in the tropical regions. *Distribution*

KEY TO THE SPECIES

Albumen of seeds uniform. Leaves always alternate.

A. Male flowers short-peduncled.

- *a*. Leaves elliptic, obtuse or obtusely cuneate at both ends. Corolla tubular. Fruiting calyx with internal elevated rim at top of its tube .. 1. *D. ebenum*.
- *b*. Leaves ovate-oblong or elliptic, subacute or obtusely acuminate. Corolla urceolate. Staminodes 4 .. 2. *D. montana*.

B. Male flowers in panicled cymes 1–1½ in. long. Corolla clothed outside with black velvety hairs. Leaves oblong, obtusely acuminate .. .. 3. *D. paniculata*.

1. Diospyros ebenum Koen.*

Fl. Brit. Ind., III, 558.

(Ebony)

Vernacular names: CENTRAL PROVINCES—Temru, Tendu; HINDI—Abnus, Ebans, Tendu; KANARESE—Bale, Kare-mara, Kari, Mallali, Malya; MALAYALAM—Karu, Mishatumpi, Vayari; MARATHI—Abnus, Tai, Tendu; TAMIL—Acha, Kaka-tati, Kakkay-tali, Karai, Karun-dali, Karun-gale, Karun-kali, Mara, May, Nulluti, Salam, Shengulan, Suli, Tai, Tumbi, Valabattiram; TELUGU—Nallavalladu, Nalluti, Tumbi, Tumiki, Tuki; URIYA—Kendhu, Khenda.

Botanical characters

A large or moderate-sized tree; heartwood jet black. Leaves up to 4 by 2 in., elliptic, obtuse or obtusely cuneate at both ends, coriaceous; reticulation hexagonal, prominent. Male flowers: 3–12 together, in short-peduncled cymes, almost fascicled on peduncles 0–¼ in. long. Calyx ⅛ in., glabrous except for the marginal ciliae; lobes 4, not reaching ½-way down. Corolla tubular, glabrous without. Stamens about 16; anthers glabrous; connective long-produced. Female flowers: solitary; ovary 8-celled. Fruit subglobose, ¾ in. diam., glabrous; fruiting calyx a subhemispheric wooden cup fitting the base of the fruit, the calyx-lobes spreading outwards.

* *D. assimilis* Bedd. is a closely allied plant and has been considered identical with *D. ebenum* by some authors. The heartwood in the former is jet black streaked with grey and brown. It is greatly valued in Travancore and considered to be a "royal timber" in the same way as *D. ebenum*. It is likely that it has the same poisonous properties as *D. ebenum*.

Distribution Found in the forests of Peninsular India and Assam.

Uses and properties This tree yields the finest quality of ebony. Pammel (*1*) records it as a fish poison.

2. Diospyros montana Roxb.*

Fl. Brit. Ind. III, 555, in part.

Vernacular names: BANDA—Makar-tendi; BANSWARA—Ambia; BENGAL—Ban-gab; BHARATPUR—Pasend; BOMBAY—Goindu, Hadru, Kundu, Temru; BURMA—Chok, Gyutbeng, Taubot; CENTRAL PROVINCES—Kadal, Kanchan, Pattevar, Patvan; GOND—Hinjalman, Poten; GUJERATI—Timbaroa, Timru; HINDI—Bis-tendu, Dasaundu, Lohari, Tendu; KANARESE—Balkunike, Bulguni, Goindu, Jagalagante, Kala-gindu, Kadu-balekayi, Kala-gunda, Tendu, Vankane; KHARWAR—Patwan; KOLAMI—Saratiril; KONKAN—Goinda; MALAYALAM—Bali; MARATHI—Goindu, Goundhan, Govindu, Lohari, Tembhurni, Tembkurni, Timburni, Timru; MEWAR—Temru; PALAMPUR—Timbaroa, Timru; PANCH MAHALS—Hadru, Temru, Timra; PUNJAB—Hirek, Keindu, Kendu, Pasendu, Temru; SANSKRIT—Tumala; SANTAL—Gada-terel; TAMIL—Vakkanai, Vakkanattan, Vellaittuvarai, Velvakkanai; TELUGU—Eddaya-gata, Erra-goda, Gatugata, Kaka-ulimera, Kaka-vulimidi, Micha-tummurra, Muchi-tanki, Muchi-tumiki, Makha, Nalla-ulimera, Nalla-vulimidi, Pudumaddi, Yerra-goda; UNITED PROVINCES—Bhori, Neori; URAN—Paten; URIYA—Bhodrika, Gouro-koshayo, Halda, Kosha-kholi, Kosse-kuli.

Botanical characters A small or medium-sized tree, sometimes armed. Leaves $2\frac{1}{2}$–4 by 1–2 in., ovate-oblong or elliptic, subacute or obtusely acuminate, usually rounded at base, ultimately glabrous. Male flowers: in short, few-flowered panicles. Calyx $\frac{1}{6}$ in. long, glabrous outside and inside; lobes 4, ciliate. Corolla white, urceolate, 3 or 4 times as long as the calyx. Stamens 16, in 2 rows of 8, in opposite pairs united at the base, the outer longest; anthers awned, glabrous. Female flowers: solitary, nodding. Staminodes 4. Ovary 8-celled. Fruit globose, 1–$1\frac{1}{2}$ in. diam., supported by the enlarged reflexed calyx-lobes, reddish-brown.

Distribution Found throughout India, *e.g.*, in the Sub-Himalayan tract from Kangra eastwards, Upper Gangetic Plain, Bihar, Orissa, Konkan, Southern Mahratta Country, Kanara, Northern Circars, the Deccan, Carnatic, and the Eastern slopes of the Ghats.

Uses and properties According to several authors the fruit is edible, while others regard it to be poisonous. The information obtained by the present authors in the field confirms the latter view; nowhere have they been told that the fruit is edible. The 'bhistis' (water carriers) apply the fruits to the painful boils which generally appear on their hands.

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* Roxburgh's *D. cordifolia* (with oblong obtuse leaves, unawned pubescent anthers, 12 staminodes in the female flowers, peduncle usually 3-flowered) referred to *D. montana* in Fl. Br. Ind. is a distinct species, and Haines (*2*) thinks Duthie's (*3*) *D. kanjilali* (with short 3-flowered cymes, elliptic-suborbicular leaves, staminodes usually 8) to be identical with *D. montana*. It would be interesting to examine the poisonous properties of these closely allied species.

The fruit is stated to be used by the hillmen of Travancore for poisoning fish (*4*). Crushed leaves are used for the same purpose in Chota Nagpur (*5*). *Fish poison*

FIG. 139. *Diospyros montana* Roxb.

3. Diospyros paniculata Dalz.

Fl. Brit. Ind., **III**, 570.

Vernacular names: KANARESE—Kuri-kumar; MALAYALAM—Illakatta, Kari, Kari-vella; TAMIL—Karun-thuvarei.

Botanical characters

A middle-sized tree. Leaves up to 9 by 3 in., oblong, obtusely acuminate, base rounded or very shortly narrowed, glabrous, subcoriaceous, finely and conspicuously reticulate. Male flowers: $\frac{1}{2}$–$\frac{3}{4}$ in. long, numerous, in panicled cymes 1–1$\frac{1}{2}$ in. long; panicles, pedicels and buds pubescent with sooty-velvety hairs. Calyx $\frac{3}{8}$ in. long, divided to the base, shortly nigro-pubescent on both sides; lobes 5, foliaceous. Corolla $\frac{5}{8}$ in. long, urceolate, outside with sooty-velvety hairs, glabrous within. Stamens 20, inserted in pairs on the corolla, glabrous. Female flowers: solitary. Calyx glabrescent. Ovary 4-celled, cells 1-ovuled. Fruit $\frac{3}{4}$–1$\frac{1}{4}$ in. long, ovoid, ferruginous hirsute; fruiting calyx enlarged, plicate, lobes auricled and imbricate at base.

Distribution Found in the forests of Southern Mahratta Country, Kanara, Malabar, and Travancore up to an altitude of 3,000 ft.

Toxicity The leaves are used as a fish poison (5).

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Family LIV.—SALVADORACEAE

(Salvadora or Mustard-tree Family)

Trees or shrubs, armed or not. Leaves opposite, entire. Flowers small, bisexual or dioecious, in panicled spikes or racemes. Calyx campanulate or ovoid, 3–5-fid. Corolla shortly campanulate or petals free, 4-merous, imbricate in bud. Stamens 4 ; filaments free or connate. Ovary superior, 1-2-, or imperfectly 4-celled ; style short ; stigma 2-fid or subentire ; ovules 1–2 in each cell. Berry or drupe mostly 1-seeded. Seed erect, globose, exalbuminous. *Botanical characters*

Tropical and subtropical regions of Asia and Africa. *Distribution*

Toothbrush tree (*Salvadora persica* Linn.) is so called from its Persian name, 'darakht-i-miswák', from the fact that toothbrushes made from it are valued on account of the belief that they strengthen the gums. It is supposed to be the mustard tree of the Bible. *S. oleoides* Decne. yields the sweet edible fruit called 'pilu' or 'jhal'. *Economic and toxic aspects*

Some of the members exhibit acrid and vesicant properties.

SALVADORA Garcin *ex* Linn.

(In honour of J. *Salvador*, a Spanish botanist.)

Unarmed. Leaves often fleshy or coriaceous. Flowers greenish ; bracts minute. Calyx campanulate ; lobes 4. Corolla campanulate ; tube short, sometimes with 4 small teeth between the bases of the filaments. Stamens 4, on the tube. Ovary 1-celled ; style 0 ; stigma truncate ; ovule 1. Drupe globose, supported by the persistent calyx and corolla. *Botanical characters*

East Africa, Arabia, India. *Distribution*

KEY TO THE SPECIES

a. Leaves up to ½ in. broad. Flowers sessile .. .. 1. *S. oleoides.*
b. Leaves $\frac{7}{10}$ in. broad or more. Flowers pedicelled .. .. 2. *S. persica.*

1. Salvadora oleoides Decne.

Fl. Brit. Ind., III, 620.

Vernacular names: ARABIC—Arak ; BOMBAY—Kakhan, Kankhina ; GUJERAT—Khakan, Khakananutela, Miti-jal, Miti-jar, Pilava, Pilu, Vakhadia ; HINDI—Bara-pilu, Jal, Jhal, Pilu ; JHALAWAR—Kator ; MARATHI—God-pilu, Khakan, Khakhan, Kinkanela, Pilu ; NASIRABAD—Pilu ; PERSIAN—Darakht-i-miswak ; PUNJAB—Diar, Jal, Jhal, Khokar, Kubbur, Pil, Pilu, Pinju, Sal, Tak, Van ; PUSHTU—Miswak, Plewan ; SANSKRIT—Dhani, Gudaphala, Kallabhaval-

labha, Karavallabha, Laghupilu, Pilu, Piluka, Shakhi, Shitasaha, Shyama, Sransi, Virechanaphala ; SIBI—Pilo, Pilu ; SIND—Diar, Kabbar, Khabbar, Mithidiar ; TAMIL—Koku, Kalawa, Karkol-ughai ; UNITED PROVINCES—Diar, Jhal, Kubbur.

Botanical characters

An evergreen shrub or small tree, with usually a short and twisted trunk ; branches spreading. Leaves 1½–3 by up to ½ in. ; linear-lanceolate or ovate-lanceolate, acute or subobtuse, often mucronate, pale-green or glaucous, glabrous. Flowers sessile, greenish-white, in erect axillary panicled spikes 1–1½ in. long, often clustered. Corolla slightly exceeding the calyx. Drupe globose $\frac{1}{6}$–$\frac{1}{5}$ in. diam., yellow when ripe.

FIG. 140. *Salvadora oleoides* Decne.

Distribution

Found in the arid tracts of Gujerat, Sind, Baluchistan, Rajputana, and the drier parts of the Punjab and on the Salt Range up to an altitude of 2,000 ft.

Uses and properties

The sweet edible fruits are very much appreciated in Northern India, but they are said to produce tingling and small ulcers in the mouth if

taken one by one ; for this reason they are eaten in handfuls, seed and all. The seeds are apt to accumulate in masses in the sigmoid flexure of the intestines and lead to disagreeable results (*1*).

The root-bark is vesicant and is used for this purpose in certain parts of the Punjab. The leaves are made into a decoction and given as a purgative to horses (*1*). Camels are very fond of browsing upon the leaves and the shoots, but no other animal will eat them (*2*). The wood furnishes an unsuitable fuel, as it smoulders and emits a disagreeable smoke (*1*).

Constituents

The leaves and the bark contain an alkaloid and trimethylamine (*3*). The stimulating effect of the fresh bark, when applied locally, is due to the latter compound (*4*).

2. Salvadora persica Linn.

Fl. Brit. Ind., III, 619.

(Toothbrush Tree ; supposed by Royle to be the Mustard Tree of the Bible)

Vernacular names: ARABIC—Arak, Irak, Kabbar, Khardal, Khar-jal, Pilu, Redif; BENGAL—Chhota-pilu, Jal, Pilu; BOMBAY—Kakhan, Khakan, Pilu, Pilva, Pilvu; GUJERATI—Khari-jal, Khari-jar, Moti-jalya, Pilu, Piludi; HINDI—Chhota-pilu, Jhak, Jal, Pilu; KANARESE—Goni; MARATHI—Khakhin, Kikni, Miraj, Mira-joli, Pilu, Rhakhan, Thora-pilu; NASIRABAD—Kabbar; PERSIAN—Darakht-i-miswak; PUNJAB—Arak, Chhota-van, Jhal, Jhar, Jhit, Jit, Kauri-jal, Kauri-van, Pilu, Van; PUSHTU—Plewan; RAJPUTANA—Jal, Jhal; SANSKRIT—Pilu; SIND—Kabbar, Khabbar, Kharid-jal, Khari-piru, Kussir, Pilu; TAMIL—Kalarva, Kargol, Kargoli, Karkol, Opa, Perungoli, Surugalarva, Sittuvila, Uba, Uga, Ughai; TELUGU—Ghunia, Gogu, Gone, Goniya, Karu-gogu, Pedda-vara-gogu, Pedda-vara-goki, Pinna-vara-gogu, Vara-gogu, Vara-goki, Vara-guwenki; UNITED PROVINCES—Jal, Jhal, Khar-jal; URDU—Pilu; URIYA—Kotungo, Pilu, Toboto.

Botanical characters

An evergreen shrub or small tree, with usually a short and crooked trunk; branches drooping. Leaves 1–2 in. by $\frac{7}{10}$–$1\frac{1}{3}$ in., elliptic-lanceolate or ovate, obtuse, often mucronate, base cuneate or rounded. Flowers greenish-yellow, in axillary and terminal compound lax panicles 2–5 in. long, numerous towards the tips of branches ; pedicels $\frac{1}{16}$–$\frac{1}{8}$ in. long. Corolla twice as long as the calyx. Drupe globose, $\frac{1}{8}$ in. diam., red when ripe.

Distribution

Found in the drier parts of India especially on saline lands and often on the black cotton soil, such as that occurring in Baluchistan, Sind, Rajputana, Bihar, Konkan, Circars, the Deccan, and Carnatic; often planted near Mohammedan tombs.

Uses and properties

The shoots, leaves, and the fruits have a pungent taste resembling mustard or garden cress. Camels are very fond of browsing upon the

plant. The fruits are not much appreciated by human beings, but are nevertheless frequently eaten.

The bruised bark of the root is acrid and acts as a quick vesicant.

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Family LV.—APOCYNACEAE

(Dogbane and Oleander Family)

Botanical characters

Trees or erect or twining shrubs, rarely herbs, usually with milky juice which is frequently poisonous. Leaves opposite or whorled, rarely alternate (*Cerbera*, *Plumeria*, *Thevetia*), entire ; stipules 0 or sometimes intrapetiolar glands. Flowers in terminal or axillary cymes. Calyx inferior ; lobes 5, rarely 4, imbricate, often glandular within at the base. Corolla rotate or salver-shaped ; lobes 5, rarely 4, spreading, contorted, rarely valvate. Stamens 5, rarely 4, on the corolla ; filaments usually short ; anthers conniving, connective sometimes adhering to the stigma, cells sometimes spurred. Ovary of 2 distinct or partially connate carpels united by the style, or carpels connate in a 2-celled ovary with axile placentas, or 1-celled with two parietal placentas ; style simple or divided at the base only, thickened at the top ; stigma 2-fid ; ovules 2-many in each cell, rarely solitary. Fruit usually of 2 free or connate follicles, or a dry or fleshy drupe, berry or samara, or of 2 drupes or berries. Seeds often with a coma of silky hairs or winged.

Distribution

Chiefly in tropical climes ; a few species occur in temperate regions.

Economic and toxic aspects

Several species belonging to this family are highly poisonous and have been responsible for poisoning both in man and animals ; many of these plants contain glucosides with digitalis-like action. A number of plants are cultivated in gardens for ornamental purposes, and several yield useful medicinal drugs containing glucosides, alkaloids, etc.

From amongst the ornamental plants grown in gardens may be mentioned : the sweet-scented oleander (*Nerium indicum* Mill., syn. *N. odorum* Soland.) with red or white, single or double flowers ; exile or yellow oleander [*Thevetia peruviana* (Pers.) Merr., syn. *T. nereifolia* A. Juss. *ex* Steud.] with yellow flowers ; red periwinkle [*Lochnera rosea* (Linn.) Reichb., syn. *Vinca rosea* Linn.] with red flowers ; pagoda tree (*Plumeria acuminata* Ait., syn. *P. acutifolia* Poir.) with fragrant white flowers having a yellow centre ; waxflower or ' chandui ' [*Ervatamia divaricata* (Linn.) Alst., syn. *Tabernaemontana coronaria* R. Br.] with pure white, single or double flowers which are delicately scented at night ; *Allamanda cathartica* Linn. with large yellow flowers, etc. ' Karonda ' (*Carissa carandas* Linn.) makes strong fences ; its fruits are universally eaten and pickled.

As stated above this family contains a number of medicinal and poisonous plants. The roots of some of them are emetic, and the milky

juice of many plants is acrid, purgative, and irritant. A number of species are cardiac poisons and contain glucosides. Some are used as fish poisons. Physiologically active alkaloids have been obtained from some of the plants. There is no doubt that besides the plants that are discussed hereafter many other species belonging to this family have toxic properties. Dita [*Alstonia scholaris* (Linn.) R. Br.] is a handsome tall evergreen tree found in a wild state in India and also much cultivated in gardens. The bark of this tree is recommended as a tonic and antiperiodic, and contains the alkaloids echitamine (ditaine), ditamine, echitenine, echitamidine (*1*) and two lactones (*2*). Conessi or 'kurchi' (*Holarrhena antidysenterica* Wall.) is an important medicinal plant used in the treatment of amoebic dysentery; its bark contains the alkaloids conessine, kurchine, kurchicine, conessimine, conessidine, concurchine, holarrhenine, lettocine, and probably several other alkaloids. *Rauwolfia serpentina* Benth. *ex* Kurz contains alkaloids which can be broadly divided into two groups, the ajmaline group and the serpentine group. It is used to reduce blood pressure, and acts as a sedative in insanity, epilepsy, and other nervous affections. *Lochnera rosea* (Linn.) Reichb. has been recommended as a remedy for diabetes; it contains an amorphous alkaloid, which acts as a cardiac poison. *Strophanthus kombe* Oliver from East Africa is a woody climber and contains the glucoside strophanthin, which acts in the same way as digitalis and is a valuable remedy in cardiac diseases. It is an important drug of the British and United States Pharmacopoeias. The bark of *Melodinus monogynus* Roxb. is used as a fish poison. There are also some other plants of this family which have been recorded as poisonous to fish.

Nerium indicum Mill. is highly poisonous. The roots, bark, and seeds of this plant contain the toxic principles neriodorin, neriodorein, and karabin. The milky juice of *Thevetia peruviana* (Pers.) Merr. is poisonous. The seeds of this plant contain the toxic glucosides thevetin, thevetoxin, ahouain, etc.; the first-mentioned is a strong heart poison. The milky juice of 'utalam' or 'dabur' (*Cerbera manghas* Linn., syn. *C. odollam* Gaertn.) possesses emetic and purgative properties, and the green fruits are employed to destroy dogs. The seeds of this plant contain a glucoside named cerberin with a digitalis-like action. The roots of *Plumeria acuminata* Ait. are stated to be violently cathartic. The milky juice of this plant is rubefacient and purgative.

A number of foreign plants are also reported to be poisonous. Some species of *Strophanthus* have been employed as arrow poisons in Africa and the Malay Archipelago; these are intensely poisonous. Strophanthin is the important glucoside found in some of the species and has been mentioned above. Oleander (*Nerium oleander* Linn.) in Europe has

been known for a long time to be poisonous, and has produced deaths among man and livestock; it contains glucosides with a digitalis-like action. The plant is reported to be very rarely cultivated in India. The juice of *Acokanthera venenata* G. Don of South Africa has been used as an arrow poison by Bushmen and Hottentots, and the plant has frequently been recorded as a cause of poisoning in both man and animals. It contains a glucoside which has a digitalis-like action (*3*). The ordeal tree of Madagascar (*Cerbera tanghin* Hook.) produces a very poisonous narcotic seed. It is used by the natives as a poison, and formerly criminals were put to death by being pricked with a lance dipped in the juice of the kernel. A single seed is said to contain enough poison to kill twenty persons (*4*). *Apocynum cannabinum* Linn. of America has been reported to have poisoned horses, cattle, and sheep both in the green and the dried state. The root of this plant contains the toxic glucoside cymarin, which is a cardiac poison (*5*).

Constituents

Members of this family are rich in toxic glucosides and physiologically potent alkaloids. They have been found to contain: (*a*) *glucosides,* such as e-strophanthin, g-strophanthin (ouabain), h-strophanthin, k-strophanthin, l-strophanthin, thevetin, thevetoxin, neriodorein, neriodorin, oleandrin, acocanthin, androsin, apocynamarin, cymarin, apocynein, carissin, echugin, rosaginin, cerberin, cerberid, sarmentocymarin, etc., and (*b*) *alkaloids,* such as conessine, kurchine, kurchicine, conessimine, conessidine, conkurchine, holarrhenine, lettocine, serpentine, serpentinine, ajmaline, rauwolfine A and B, ajmalicine, ajmalinine, echitamine, alstonine, villalstonine, macralstonine, macralstonidine, etc.

KEY TO THE GENERA

A. Anthers included, free from the stigma, the cells rounded at the base.
  - I. Ovary of 2 wholly combined carpels. Style entire at base.
    - *a.* Ovary 1-celled. Fruit a spinescent capsule .. 1. *Allamanda.*
    - *b.* Ovary 2-celled. Fruit a berry, pericarp coriaceous or hard .. .. .. 6. *Melodinus.*
  - II. Ovary with the 2 carpels often appressed but distinct, usually united only by the style (the style appearing split at base) but occasionally also at their base (*Rauwolfia*) or throughout (*Thevetia*); if united throughout, the fruit is indehiscent but not pulpy within.
    - *a.* Leaves alternate.
      - *aa.* Ovules few in each carpel. Corolla funnel-shaped. Fruit drupaceous or baccate.
        - 1. Calyx glandular. Flowers large, yellow .. .. .. 11. *Thevetia.*
        - 2. Calyx eglandular. Flowers white or red .. .. .. 2. *Cerbera.*

bb. Ovules many. Corolla salver-shaped. Fruit follicular. Seeds winged .. 8. *Plumeria.*

b. Leaves opposite. Ovules many in each carpel. Fruit follicular.

aa. Herbs or undershrubs. Flowers white or pink. Disc of 2 glands. Seeds truncate at both ends .. .. 5. *Lochnera.*

bb. Trees or shrubs. Flowers white.

1. Calyx glandular. Follicles stout, fleshy. Seeds arillate 3. *Ervatamia.*

2. Calyx eglandular. Follicles long, slender. Seeds comose 4. *Holarrhena.*

c. Leaves whorled. Shrubs or undershrubs. Ovules 2 in each carpel. Fruit drupaceous. 9. *Rauwolfia.*

B. Anthers included, conniving in a cone round and adherent to the stigma, the cells produced at base in an empty spur. Corolla-mouth with 5–10 scales. Seeds comose.

I. Erect shrubs. Leaves whorled. Corolla-lobes short. Follicles erect .. .. 7. *Nerium.*

II. Shrubby or climbing. Leaves opposite. Corolla-lobes long or tailed. Follicles spreading .. 10. *Strophanthus.*

1. ALLAMANDA Linn.

(In honour of J. N. S. *Allamand*, a Swiss scientist.)

Botanical characters

Shrubs, usually climbing, sometimes small trees. Leaves shortly petioled, with intrapetiolar glands. Flowers very large, usually yellow, in few-flowered cymes. Corolla with a short tubular base, then suddenly campanulate; lobes rounded, contorted to the left; throat with a ring of ciliate scales. Ovary 1-celled; style filiform; ovules many. Fruit globose, with numerous stout green prickles, dehiscing by 2 valves.

Distribution

Tropical regions of America, West Indies; several species are cultivated in gardens.

Allamanda cathartica Linn.

Vernacular names: BENGALI—Har-kakra; BOMBAY—Jahari-sontakka, Pili-kaner, Pivli-kanher; KANARESE—Arasin-hu; KONKANI—Kanangani; MUNDARI—Araba.

Botanical characters

An erect or subscandent shrub $6\frac{1}{2}$–13 ft. high. Leaves in whorls of 3 or 4, or the uppermost scattered, 5 in. long, lanceolate or oblanceolate, acuminate, sessile, shining above. Flowers yellow. Corolla about 3 in. long, the slender part of the tube $1\frac{1}{5}$ in. long, then inflated and about $\frac{4}{5}$ in. diam., the lobes ovate or oblong-ovate, about $\frac{4}{5}$ in. long.

Distribution

Originally from America, this plant is now widely grown in Indian gardens; sometimes it is found to run wild, as along backwaters in Travancore.

The extract of the bark in doses of 1 to 2 grains is stated to be an excellent hydragogue cathartic. In large doses, all parts of the plant are violently emetic and cathartic (*6*). *Toxicity*

FIG. 141. *Allamanda cathartica* Linn.

2. CERBERA Linn.

(After the fabled dog *Cerberus*—the watchdog of the infernal regions whose bite was poisonous ; referring to the poisonous properties.)

Botanical characters

Small trees or large shrubs. Leaves alternate ; nerves horizontal and parallel. Flowers large, white or red, in terminal cymes. Calyx 5-partite, eglandular. Corolla funnel-shaped ; tube short ; throat ribbed or with pubescent scales ; lobes 5, broad, spreading, longer than the tube, overlapping to the left. Stamens included. Disc 0. Carpels 2, distinct ; ovules 4 in each carpel, on both sides of a thick placenta. Fruit of 1, rarely 2, globose or ovoid or ellipsoid 1–2 -seeded drupes ; pericarp very thick, fibrous and woody. Seeds broad, compressed, exalbuminous.

Distribution

Indo-Malaya, Madagascar.

Cerbera manghas Linn.

C. odollam Gaertn., Fl. Brit. Ind., III, 638.

Vernacular names: BENGAL—Dabur, Dhakur; BURMA—Ka-lwah; KANARESE—Chande, Honde, Monde, Tende; MADRAS—Kadal-alari; MALAYALAM—Chattan-kaya, Ponna, Othalam, Utalam; MARATHI—Sukanu; SUNDARBANS—Dabur, Dakur; TAMIL—Kadal-ma, Kada-ma, Kad-arali, Kat-arali, Kattu-ma, Udalai.

Botanical characters

A small tree or large shrub; branchlets whorled, stout, marked with leaf-scars. Leaves closely set at the ends of the branches, 5–10 by 1½–2½ in., coriaceous, black when dry, lanceolate, oblanceolate or oblong-obovate, suddenly acuminate, much tapering to the base. Flowers large, odorous, white with a yellow throat which is nearly closed by 5 pubescent projecting wing-like ribs. Fruit (from the suppression of 1 carpel) a drupe 2–4 in. long, subglobose, smooth, green.

Distribution

Found throughout India in the salt swamps or on the seacoast; abundant on the Malabar coast, but not very common in the Bombay Presidency and elsewhere.

Uses and properties

The whole plant abounds in a milky juice, and to this and to the leaves emetic and purgative properties are assigned; the bark also contains cathartic principles. Their use should, however, be condemned since there are a number of safer and more efficient medicines of both classes. There is reason to believe that, even in moderate quantities, products from this plant produce toxic effects (*7*). Pammel (*4*) records the plant as a fish poison.

The nut is narcotic and poisonous, and the green fruit is employed to destroy dogs. The kernel of the fruit is an irritant poison, producing, when taken internally, vomiting and purging, soon followed by collapse and death. The poisonous juice of the fruit was formerly used in Madagascar as an ordeal in cases of suspected crime or apostacy (*7*).

Constituents and action

The seeds contain a poisonous glucoside, cerberin, having a digitalis-like action. In dogs, cats and rabbits, subcutaneous injections produce vomiting, diarrhoea, paralysis of the heart, and rise of blood pressure. The lethal dose for dogs is 1·8 mg, for cats 3·1 mg, and for rabbits 50 mg per kgm (*8*).

Studies carried out by the authors show that cerebrin is very sparingly soluble in water. A saturated solution at 30°C., which was used for experimental purposes, had the strength of about 1 in 5,000. This solution when applied to unbroken skin did not produce any local irritation; subcutaneous injections of 1 c.c. of the solution in a guinea pig did not produce any local inflammation. The application of a few drops into the eye of a rabbit produced no irritant action. Intravenous injections of 0·5 to 1 c.c. produced a well-marked and persistent rise of blood

pressure, definite slowing of the heart, and increase in the force of contraction of both the auricles and ventricles.

3. ERVATAMIA Stapf

(After *Ervatamius*.)

Botanical characters

Shrubs or small trees. Leaves opposite; axillary stipules usually distinct; axillary glands small, often numerous. Flowers white, in cymes, often in pairs. Calyx small; lobes 5, glandular inside. Corolla salver-shaped; tube cylindric, slightly dilated towards the naked mouth; lobes overlapping usually to the left. Stamens included. Disc 0. Ovary of 2 free, sometimes slightly coherent carpels; style usually long, filiform; stigma clavate or oblong with a bifid apiculus; ovules numerous, many seriate. Follicles 2, coriaceous when mature, obliquely ovoid to lanceolate, usually curved and beaked. Seeds few to many, enveloped in an orange or red aril; albumen copious.

Distribution

Tropical regions of Asia, Australia, Polynesia, and Madagascar.

Toxic aspects

E. dichotoma (Roxb.) Blatter (*Tabernaemontana dichotoma* Roxb.) is poisonous. There are a couple of other species growing wild or cultivated in the gardens in India, notably the waxflower [*E. divaricata* (Linn.) Alst., syn. *Tabernaemontana coronaria* R. Br.] with pure white flowers. Two physiologically active alkaloids, tabernaemontanine and coronarine, have been isolated from *E. divaricata* (*9*).

Ervatamia dichotoma (Roxb.) Blatter

Tabernaemontana dichotoma Roxb., Fl. Brit. Ind., III, 645.

(Eve's-apple Tree)

Vernacular names: TAMIL—Kat-arali.

Botanical characters

A small dichotomously branched tree; young parts glabrous, covered with a shining resinous coat. Leaves 4–7 in. long, lanceolate-oblong, tapering to the base, suddenly and shortly acuminate, obtuse, stiff and coriaceous, dark-green above; main nerves 10–22 pairs at right angles to the midrib and meeting in loops, impressed above; petiole $\frac{1}{2}$–$1\frac{1}{4}$ in., stout. Cymes few-flowered; peduncles 2–6 in. long, stout; pedicels stout. Corolla $1\frac{1}{2}$–3 in. diam.; tube $\frac{4}{5}$–1 in., fleshy; lobes considerably longer, falcately twisted, often crisped at margin. Ripe carpels broadly ovoid, blunt, smooth, orange-yellow. Seeds surrounded by a coat of crimson pulp.

Distribution

Found in the Western Ghats, in Malabar, at low levels; occasionally grown in gardens for ornamental purposes.

The fruit of this plant has a tempting appearance and is called "The Forbidden Fruit of Eden" by the Mohammedans; in South

Europe it is called "Eve's-apple". It is said to be deadly poisonous. Watt (7), on the authority of Ainslie, states that "the seeds are said to

FIG. 142. *Ervatamia dichotoma* (Roxb.) Blatter.

be powerfully narcotic and poisonous, producing delirium and other symptoms similar to those caused by Datura. They are said by Lindley to be purgative. The leaves and bark act as purgatives and are believed to be used in Java as a substitute for senna; the milky sap is also described as cathartic".

4. HOLARRHENA R. Br.

(From the Greek *holes*—whole, entire, and *arren*—male; referring to the anthers being free from the stigma.)

Botanical characters

Trees or shrubs. Leaves opposite, membranous Flowers white, in terminal or subaxillary corymbose cymes. Clayx 5-lobed, usually

glandular within. Corolla salver-shaped; tube slender; throat contracted, naked; lobes overlapping to the right. Stamens near the base of the tube. Disc 0. Carpels 2, distinct; style short; ovules many. Follicles 2, elongate, diverging, incurved, terete. Seeds tipped with a deciduous coma.

Tropical regions of Asia and Africa. *Distribution*

Holarrhena antidysenterica Wall.

Fl. Brit. Ind., III, 644.

(Conessi Bark, Kurchi Bark—the commercial names of the bark)

Vernacular names: ARABIC—Lasanul-assafirul-murr, Tivraja; ASSAM—Dudkory; BENGAL—Kurchi, Tita-indarjau; BERAR—Dudhiari, Dudi, Kura-khatto; BHIL—Ankhria; BIHAR—Inderjau-talkh, Indrajab, Lisanul-asufir: BOMBAY—Dola-kura, Dowla, Indrajau, Karva-indarjou, Kura, Pandhra-kura: BURMA—Leton-kgyi, Letou-kgyi, Lettop-gyee; CACHAR—Madmandi; DECCAN—Dola-kura, Karva-indarjou, Pandhra-kura; GARO—Madmandi: GOND—Girchi. Samoka; GUJERATI—Dhowda, Hath, Hathbaha, Indrajwanun, Kado, Kadvo-indarjou, Kari, Kuda; HINDI—Dhudi, Dudhi, Hat, Indarjau, Karchi, Kari, Karra, Kaura, Kaureya, Karva-indarjau, Kora, Kuar, Kurchi, Kureya, Kura; JAIPUR—Karru; KANARESE—Beppale, Hale, Hire-kodasige, Kodasige, Kodamurrike, Koodsalu, Korchu, Kudsalu, Nangu, Sanna-hale, Vatsaka, Veppale; KASHMIR—Keor, Kewar, Kor; KHARWAR—Koraiya; KHOND—Khorhoi, Pardali; KOLAMI—Hat, Kuar, Kuti, Towa, Tuar; KONKANI—Davo-kudo, Khao, Kodaga, Koru, Kudo, Kura, Kuria, Kurro; KUMAON—Dudhi, Kachri, Kura; LEPCHA—Fajeerip; MALAYALAM—Kaipa-kotaka-pala, Kodaga-pala, Kotaka-pala, Pala, Pala-patta, Pani-palai, Ven-pala; MARATHI—Bedaki, Dola-kuda, Kadu-indrajou, Kodaga, Kuda, Kurra, Pandhara-kuda, Pandhara-kura; MISHMI—Dudhali, Dudhkuri; MONGHYR—Dudhia; NEPAL—Karingi, Kirra, Kura; OUDH—Kachri; PERSIAN—Indarjave-talkh, Tukhme-ahare-talkh, Zabane-kunjashke-talkh, Zabani-gungishki-talkh; PORBANDAR—Kari-khado; PUNJAB—Inderjau, Kawar, Kewar, Kiam, Koeva, Kogar, Kura; RAMNAGAR—Kwera; SANSKRIT—Indrayava (seeds), Kalinga, Kutaja; SANTAL—Hat; SIMLA—Kura; TAMIL—Erukkalai-palai, Indrabam, Kalingam, Kasap-puve-palai, Kashappu-vetpa-larishi, Kirimalligai, Kudaga-palai, Kudasa-palai, Kula-palai, Palai, Vattagam, Vepali, Veppalai; TELUGU—Amkudu-vittulu, Amkudu-vittum, Chedu-kodise, Girimalika, Istaraku-pala, Kaka-kodise, Kalingamu, Kodaga, Kodise, Kodise-pala, Kolamukhi, Kutajamu, Manu-pala, Pala, Pala-barrai, Pala-kodise, Pala-kodsa, Peddan-kudu, Vistaraku-pala; THARU—Koriya; TULU—Kodanji; UNITED PROVINCES; Kuar, Kuer, Kura, Moriya; URAN—Korkoria; URIYA—Kherwa, Khurni, Krya, Kuda, Kure, Patru-kurwan, Pita-korwa, Pitta-krya, Potro-krya.

A large shrub or small tree. Leaves somewhat distichously spreading, subsessile, glabrous, pubescent or tomentose, 6–12 by $1\frac{1}{2}$–5 in., ovate to elliptic-oblong, apex rounded or obtusely acuminate, base usually obtuse or rounded. Flowers white, sweetly scented, $\frac{3}{4}$–$1\frac{1}{2}$ in. diam., in terminal corymbose cymes 3–6 in. wide; corolla-tube $\frac{2}{5}$ in. long, pubescent. Follicles slender, divaricate, 6–16 in. long by $\frac{1}{6}$–$\frac{1}{2}$ in. in diam. Seeds with a long brown coma. *Botanical characters*

Found more or less throughout India, ascending to an altitude of 4,000 ft. in the Western Himalayas. *Distribution*

Uses and properties

It appears that cattle and goats do not browse upon the leaves. The bark is very bitter and has been used for a very long time in indigenous medicine as a cure for dysentery. The seeds and to some extent the leaves are also used in medicine, the former being considered to have astringent, febrifugal, antidysenteric, and anthelmintic properties.

FIG. 143. *Holarrhena antidysenterica* Wall.

Constituents and action

The bark and to a lesser extent the seeds contain the alkaloids conessine, kurchine, kurchicine, conessimine, conessidine, conkurchine, holarrhenine, lettocine, and probably several others (*10*).

Kurchicine is a general protoplasmic poison. The minimum lethal dose in white mice by intravenous injection is 38·12 mgm per kgm. The heart is depressed; there is a well-marked fall in blood pressure. With toxic doses there is a definite slowing of the beat followed by a complete heart block. The alkaloid also produces a marked dilatation of the

vessels of the splanchnic area. The respiration is first stimulated, but with large doses it is quickly arrested. The plain muscle of the uterus and intestine is stimulated even in such high dilutions as 1 : 500,000 (*11*).

Knowles (*12*) reported regarding the curative value of tablets prepared from the bark of this plant in the treatment of amoebic dysentery. Acton and Chopra (*13*) showed that in acute amoebic dysentery the total alkaloids of kurchi bark administered either by the subcutaneous route or by mouth are as powerful as emetine both as regards their immediate effect on the symptoms and for curative value. Except for a slight inflammation at the site of the injection no untoward symptoms were produced. The total alkaloids are much less toxic than emetine in so far as other effects on the heart and the nervous system are concerned. In chronic intestinal amoebiasis, bismuthous iodide compound of the total alkaloids given orally in doses of 10 grains daily compared favourably with emetine bismuth iodide, and it did not produce vomiting or depression. These alkaloids, however, have no action in amoebic hepatitis (*14*).

5. LOCHNERA Reichb.

(In honour of M. Fr. *Lochner*, 1662–1730, a German botanist.)

Botanical characters

Herbs or undershrubs. Leaves opposite, axillary glands numerous. Flowers axillary, solitary or in pairs, white or pink. Calyx 5-partite, eglandular. Corolla salver-shaped; tube slender; throat constricted; lobes overlapping to the left. Stamens included. Disc of 2 linear glands. Carpels 2, free; style filiform; stigma depressed-capitate with a reflexed hyaline frill at base, the apiculus 2-lobed; ovules numerous, 2-seriate. Follicles cylindric, slightly spreading. Seeds many, small, truncate at both ends; albumen fleshy.

Distribution

Tropical regions.

KEY TO THE SPECIES

a. Leaves lanceolate. Flowers $\frac{1}{4}$ in. diam. .. .. 1. *L. pusilla*.
b. Leaves ovate to obovate. Flowers 1–2 in. diam. .. 2. *L. rosea*.

1. Lochnera pusilla (Murr.) K. Schum.

Vinca pusilla Murr., Fl. Brit. Ind., III, 640.

Vernacular names: BOMBAY—Sangkha-phuli, Sangkhi, Sankaphi; MALAYALAM—Kapa-vila.

Botanical characters

An erect, much-branched, pale-green annual 6–24 in. high; stem and branches acutely 4-angled. Leaves membranous, $1\frac{1}{2}$–3 in. long, lanceolate, acuminate, tapering to the base, margins rough. Flowers $\frac{1}{4}$ in. diam. Corolla-tube $\frac{1}{3}$ in. long; mouth hairy, throat glabrous inside; lobes apiculate. Follicles $1\frac{1}{2}$–2 in. long, slender, striate.

Distribution

Found in the Western Himalayas, Upper Gangetic Plain, Bihar, Orissa, Sind, Gujerat, Konkan, the Deccan, Southern Mahratta Country

and Carnatic, ascending up to an altitude of 2,000 ft. A common weed in many places.

Toxicity Very little is known regarding the medicinal properties of this plant. Gamble (*15*), however, mentions that it is regarded as poisonous to cattle.

Constituents It contains an amorphous alkaloid named vincarosine, which is a heart poison (*16*).

2. Lochnera rosea (Linn.) Reichb.

Vinca rosea Linn., Fl. Brit. Ind., III, 640.

(Red Periwinkle.)

Vernacular names: BENGAL—Nayantara; BURMA—Thembanmahnyoban; MARATHI—Sadaphul; NASIRABAD—Ratanjot; PUNJAB—Rattanjot; TELUGU—Billaganneru; URIYA—Ains-kati.

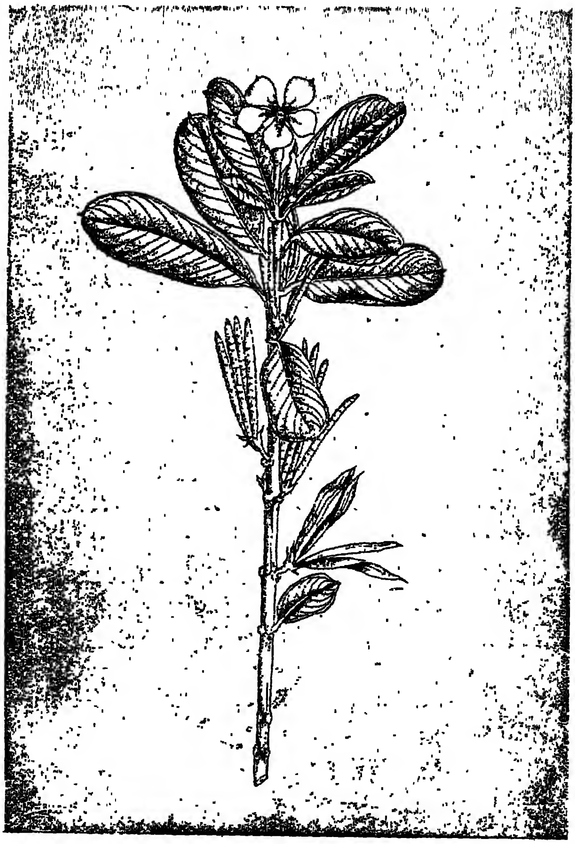

FIG. 144. *Lochnera rosea* (Linn.) Reichb.

Botanical characters

An evergreen undershrub 2–3 ft. high. Leaves $1\frac{1}{2}$–2 in. long, ovate to obovate, glossy-green above. Flowers 1–2 in. diam., rosy or white, in axillary pairs. Corolla-tube $\frac{4}{5}$ in. long. Follicles 1 by $\frac{1}{10}$ in.

Distribution

A native of the West Indies; commonly grown in the Indian gardens where it springs up readily self-sown.

Uses

This plant is used as a remedy for diabetes particularly in Natal, also in other parts of South Africa and in Queensland. It is also used in the treatment of menorrhagia, being generally administered in the form of an infusion of the leaves.

Constituents and action

It contains an amorphous alkaloid which acts as a heart poison (*16*). More recently Cowley and Bennett (*17*) have isolated 0·53 to 0·85 per cent of an alkaloidal residue from the leaf.

Corkill and Doutch (*18*), using an extract of the leaf, could not confirm its utility in diabetes, but found the preparation to be an ideal purgative in chronic constipation. Any benefit derived by diabetics from this plant is due probably to its weak digitalis-like and purgative actions.

6. MELÓDINUS Forst.

(Etymology obscure.)

Botanical characters

Evergreen, erect or climbing, unarmed shrubs. Leaves opposite. Cymes terminal and axillary; flowers rarely 4-merous, white or pale-pink. Calyx 5-partite, eglandular within. Corolla salver-shaped; mouth with thick cleft or lobed scales; lobes overlapping to the left. Anthers included, subsessile. Disc 0. Ovary 2-celled; Ovules many in each cell. Berry globose, pericarp coriaceous or hard. Seeds many, embedded in pulp; albumen fleshy.

Distribution

Indo-Malaya.

Melodinus monogynus Roxb.

Fl. Brit. Ind., III, 629.

Vernacular names: BENGALI—Sandul-kon; KHASIA—Echalat, Sadul-kou; SYLHET—Echalat, Sadul-kou.

Botanical characters

A tall climber. Leaves 5–6 by $1\frac{1}{2}$–2 in., pale-brown when dry, oblong or oblong-lanceolate, acute or obtuse, base acute or rounded. Panicles terminal. Flowers nearly white, fragrant. Corolla-tube $\frac{1}{2}$–$\frac{3}{4}$ in. long, villous within; lobes as long, oblong, obtuse; scales lobed. Berry globose, obscurely 4-angled, size and colour of an orange.

Distribution

Found in Cooch Behar, near Purnea, the Sikkim Himalayas, Sylhet, Khasia Hills and other places in Assam; ascending to an altitude of 4,000 ft.; sometimes cultivated in gardens.

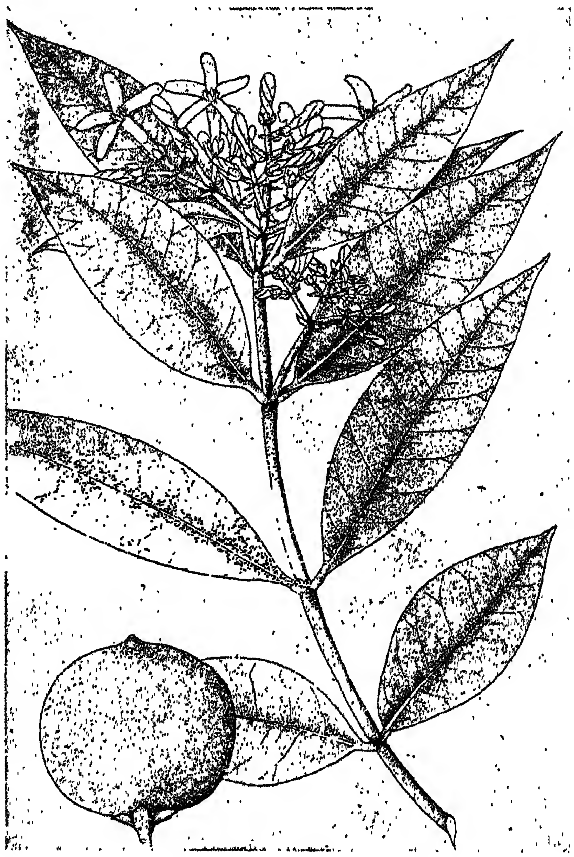

FIG. 145. *Melodinus monogynus* Roxb.

Uses and properties

The fruit is eaten by people in Sylhet, and is said to be sweet and agreeable. The bark contains a quantity of fibrous matter, which is used as a substitute for hemp. Roxburgh, while steeping some of the young shoots in a fish pond, in order to accelerate the removal of the bark and to clean the fibre, found that many if not all the fish were killed, hence his name *Nerium piscidium* for the plant (*7*).

Constituents

A foreign species, *M. laevigatus* Blume, contains poisonous alkaloids in the leaves, bark, and seeds (*19*).

7. NERIUM Linn.

(From *nerion*, the Greek name used by Dioscorides for the oleander, *N. oleander* Linn., derived from the Greek *neros*—humid ; referring to the habitat of the plant.)

Botanical characters

Erect shrubs. Leaves 3–4-nately whorled, rarely opposite, narrow, coriaceous. Flowers large, in terminal racemose cymes. Calyx 5-partite, glandular within. Corolla funnel-shaped; tube cylindric, expanding above, with 5 fringed scales on the throat; lobes overlapping to the right. Stamens at the top of the tube, included ; anthers adhering to the stigma, tips filiform, cells spurred at the base. Disc 0. Carpels 2, distinct, many-ovuled; stigma with a reflected lobed membrane surmounted by 5 tubercles, tip subglobose. Follicles cylindric, straight, appressed. Seeds villous; coma terminal; albumen fleshy.

Distribution

From the Mediterranean region to North Asia and Japan.

KEY TO THE SPECIES

a. Leaves linear-lanceolate. Flowers fragrant. Sepals erect .. .. 1. *N. indicum.*

b. Leaves lanceolate. Flowers inodorous. Tips of sepals often patent .. .. 2. *N. oleander.*

1. Nerium indicum Mill.

N. odorum Soland., Fl. Brit. Ind., III, 655.

(Indian Oleander, Sweet-scented Oleander)

Vernacular names: ARABIC—Difli, Sum-el-himar; BALUCHISTAN—Gandeli, Jaur. Jowări; BENGALI—Karabi; BOLAN HILLS—Jaur; BOMBAY—Ganira, Kanher, Kanhera, Kanir; DECCAN—Kanir; GUJERATI—Kanera; HINDI—Karber, Karpad, Kanel, Kaner, Kuruvira; KANARESE—Bili-ganagile, Bili-gampu-ganagile, Deva-ganigalu, Kanagile, Karavira, Kempu-ganagile, Paddali; KUMAON—Kanur, Kanyur; MALAYALAM—Alari, Arali, Chuvannarali, Kanaviram, Karaviram, Rakta-pushpam, Satraprasam, Veluttarali; MARATHI—Kaneri, Kanher; MUNDARI—Kanaili; PERSIAN—Khar-zahrah; PUNJAB—Ganera, Ganhira, Ganira, Kaner, Kanira; PUSHTU—Ganderai; RANIKHET—Kanpuri; SANSKRIT—Asvamaraka, Chandata, Hayamaraka, Karavira, Pratihasa, Sataprasa, Virahuha, Vishavrykshanka; SANTAL—Rajbaha, Rajbaka; SIBI—Jaur; TAMIL—Agam, Alari, Alarida, Arali, Aralivayr, Asuvabari, Irattaichegappayalari, Irattaichivappalari, Kanaviram, Karaviram, Kaviram, Katturepatta, Kayiram, Sevvalari, Urattai-vellaiyalari, Vellalari, Vellaiyalari; TELUGU—Etta-ganneru, Ganneru, Gheneru, Karaviram, Kasturi-patta; URDU—Kanir; URIYA—Konero, Konioro, Koniyoro, Korobe, Korobiro, Korobyo.

Botanical characters

A large glabrous evergreen shrub. Leaves in threes, shortly stalked, 4–6 in. long, linear-lanceolate, acuminate, dark-green and shining above. Flowers $1\frac{1}{2}$ in. diam., red, rose or white, fragrant. Follicles 6–9 in. long. —Closely allied to the European oleander, *N. oleander* Linn.

Distribution

Found in the Himalayas from Kashmir to Nepal up to an altitude of 6,500 ft., in the Punjab Salt Range extending westwards to Baluchistan, and also in the United Provinces and Central India. Cultivated

in gardens throughout India with single or double flowers; apparently wild in South India and in the Bombay Presidency along the banks of streams.

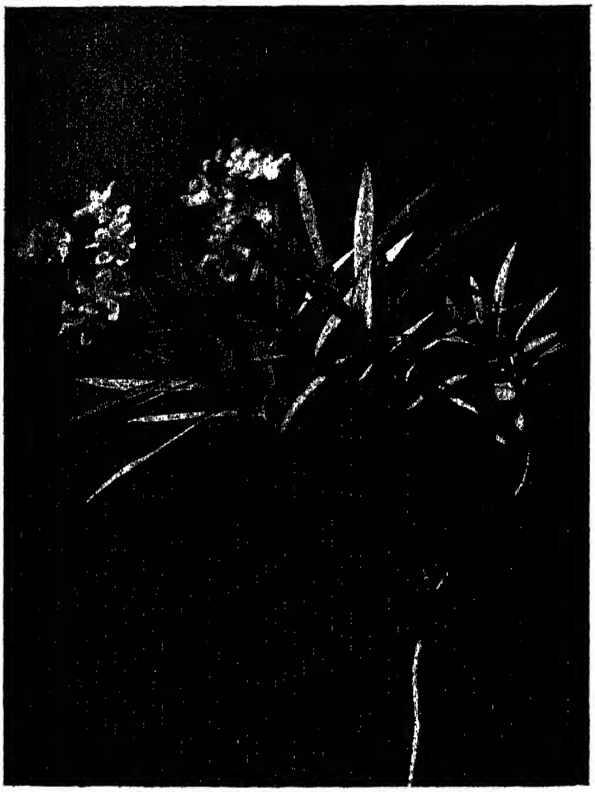

FIG. 146. *Nerium indicum* Mill.

Toxicity

This plant has several Sanskrit names, such as 'asvamaraka' (signifying "horse killer"). The Persian and Arabic names 'difli', and others, *viz.*, 'sum-el-himar' and 'khar-zahrah', all signify "asses'-bane" —a curious fact, since the Italian name 'ammazza l'asino' (applied to the allied European plant, *N. oleander* Linn.) has the same meaning.

All parts of the plant are poisonous, and it is not eaten by cattle. According to Watt (7), "The goat appears to be able to feed on the foliage of this plant with impunity, but it proves fatal to camels and all other animals". This statement so far as it concerns goats is surprising and requires verification. According to Stewart, the stalks are in some places used as 'hookah' tubes, the wood probably imparting

a narcotic principle to the tobacco smoke. Such use, however, has not been observed by the present authors. The rasped wood is used in some parts of India for killing vermin. The powdered bark of the common oleander of Europe (*N. oleander* Linn.) is said to be employed for a similar purpose by the peasantry in the South of France (*7*).

Cases of poisoning by the plant are not very often reported. Several suicidal, homicidal and abortion cases are, however, on record in India. For suicidal purposes, the root is especially used in Western and Southern India and in the outer Himalayas, but less commonly for homicidal purposes. It is, however, commonly used for procuring criminal abortion both by local application and internal administration. The use of the root in the treatment of venereal diseases by the uninitiated has occasionally led to fatal poisoning. The Mundas use the seeds to poison pigs and jackals. In fact the poisonous properties are so well known in India that it is a proverbial taunt among females to say "Go and eat the 'kaner' root".

Constituents and toxicology

The roots, bark, and seeds contain the toxic principles neriodorin, neriodorein, and karabin (*20*, *21*). Like neriodorin, karabin is a powerful cardiac poison, acting on the heart in a somewhat similar manner to digitalin, and it also acts on the spinal cord in more or less the same way as strychnine (*21*).

Half a grain of karabin proved almost fatal to a cat, and two grains of nerioderin killed a cat in 15 minutes. One grain of either of these substances may, therefore, be considered to be the fatal dose for an adult cat. From an analogy of the action of other vegetable poisons on cat and man, it is probably correct to state that the fatal dose of either of these principles for man would probably be five times more than that for a cat. As the root contains about one per cent of karabin and probably an equal amount of neriodorin, 250 grains (about ½ ounce) of the root (which would yield 5 grains of the two active principles) may be taken as the average fatal dose for an adult human being; 180 grains of the root have produced alarming symptoms in a man, although fatal results did not follow. The toxic properties of neriodorein are of a much milder character than those of either karabin or neriodorin (*21*).

Honigberger was of opinion that the wild hill-plant was more poisonous than the cultivated variety. He is supported in this opinion by Latour and Pelikan, who found by careful analysis that the wild variety contained a larger quantity of the poisonous principles (*21*).

Latour, after making careful chemical examination of the plant, came to the conclusion that the poisonous principles reside in the leaves, flowers and bark, but most largely in the bark. It may be of interest to note that the smell of the flowers is quite nauseating to some people (*7*).

Symptoms in man

Fatal symptoms are manifested by a depression of the nervous functions and particularly of the heart (*7*). Vomiting and frothy salivation usually occur, followed by restlessness. The pulse becomes slow and weak, respiration hurried, and muscular twitchings especially of the upper extremities deepening into tetanic spasms follow, which (unlike strychnine poisoning) affect one side more than another. Lockjaw is frequently present. Drowsiness sets in passing into loss of consciousness and collapse. Diarrhoea is sometimes present (*21*).

Symptoms in horse

Snipe (*22*) gave to a horse 2 ounces of the leaves evening and morning for three days, and they were readily taken with food. He observed a dull abdominal pain, anorexia, with yellowishness and injection of the conjunctivae; there was no narcosis and the temperature remained normal.

Post-mortem appearance

The lesions were chiefly intense congestion of the small intestines, particularly of the duodenum and jejunum. The coecum and colon were similarly affected and their contents were liquid and sanguinous. There was patchy congestion of the stomach, especially at the cardiac end (*22*).

Treatment

The general treatment is as for digitalis and strychnine poisoning. Injections of morphine and ether seem to be beneficial.

2. **Nerium oleander** Linn.

Fl. Brit. Ind., III, 655, without description.

(Laurier-rose, Oleander)

Botanical characters and distribution

According to Haines, this plant, the oleander of Mediterranean region, is sometimes met with in gardens. The chief points of difference between this and *N. indicum*, as stated by him, have been referred to in the key. A further difference appears to be in the depressed 2-fid, less umbonate stigma, according to De Candolle.

Toxicity

The plant has been known to be poisonous for a very long time and has produced deaths among human beings, cattle, horses, goats, sheep, fowls, ducks, and geese in foreign countries.

Constituents

The leaves contain the glucosides neriin and oleandrin. These are distinct chemical compounds, different from the glucosides of strophanthus and should not be called 1-strophanthin as suggested by Leulier (*23*), who reported the presence of a toxic glucoside called by him 1-strophanthin from the bark and fruits in addition to the leaves. He also reported another feebly toxic glucoside in the sap.

Another glucoside, folinerin, has been isolated from the leaves. Its effect on pulse, diuresis and congestive symptoms, in cases of cardiac

insufficiency, is more or less complete and resembles digitalis, the diuretic action being especially marked. No unpleasant side actions or cumulative symptoms were observed after the usual treatment for 8 to 10 days. The action is not only complete but prolonged. Folinerin is, therefore, important as a cardiac stimulant because it is a stable glucoside with known composition, shows constant activity, and does not need biological standardization (*24*).

Toxic dose

According to Wilson, the minimum lethal dose for the horse is 15 to 20 gm of green leaves and 15 to 30 gm of dry leaves ; for the cow, it is 10 to 20 gm of green leaves and 15 to 25 gm of dry leaves ; and for sheep, 1 to 5 gm of either green or dry leaves. It is stated that a few leaves may cause death in human beings (*4*).

Symptoms

The symptoms of poisoning in human beings are nausea, vomiting, colic, dizziness, irregularity of heart's action, diarrhoea, and unconsciousness. Death is due to heart failure or respiratory paralysis. In animals the symptoms are similar to those seen in human beings. At the onset the animals may exhibit pronounced excitement, but death is usually preceded by convulsions and paralysis (*27*).

Post-mortem appearance

Post mortem there is general cyanosis and hyperaemia of the gastro-intestinal tract. There may be haemorrhages in the intestinal canal, endocardium, brain, duramater, and piamater. The heart is dilated.

Treatment

Salicylic acid has been recommended by Ceccherelli (*28*) as an antidote in oleander poisoning. Respiratory and cardiac stimulants are indicated.

8. PLUMERIA Tourn. *ex* Linn.

(In honour of Charles *Plumier*, 1646–1706, a French botanist.)

Botanical characters

Small trees ; branches very thick. Leaves alternate, large, deciduous ; nerves numerous, horizontal. Flowers showy, in terminal 2–3-chotomous cymes ; bracts many. Calyx perigynous, 5-fid, eglandular. Corolla salver-shaped ; throat naked. Stamens near the base of the tube. Ovary almost inferior, of 2 distinct carpels ; ovules many-seriate in each cell. Fruit of two stout, linear-oblong or ellipsoid follicles. Seeds winged ; albumen fleshy.

Distribution

Tropical regions of America ; several species are cultivated.

Plumeria acuminata Ait.

P. acutifolia Poir., Fl. Brit. Ind., III, 641.

(Frangipane, Frangipani, Jasmine Tree, Pagoda Tree, Spanish Jasmine)

Vernacular names : Assam—Gulanchi ; Bengal—Dalana-phula, Gorur-champa ; Bombay—Chameli, Champa, Dolo-chapa, Gulachin, Khad-champo, Khair-champa, Khera-chapha, Pandhra-chapha, Sou-champa ; Burma—China-

champak, Tarok-saga, Tayop-sagah ; Dehra Dun—Gulachin, Gulchin ; Gond—Champa-pungar ; Gujerati—Rhada-champo ; Hindi—Chameli,Gobur-champ, Golainchi, Gulachin, Gulainchi, Gulchin ; Kanarese—Bel-champaka, Champaka, Deva-ganagile, Ganagalu, Go-sampige, Kadu-sampage, Kanagala, Kanagile, Mo-gaganagile ; Konkani—Portugalo-champo ; Madras—Attalari ; Malayalam—Arali, Vella-champakam, Velattalari ; Marathi—Khair-champa, Rhuru-chapha, Son-champa ; Mundari—Golanchi ; Persian—Gulachin ; Sanskrit—Deva-ganagalu, Go-sampige ; Santal—Champa-pungar, Gulanjbaha ; Tamil—Ilattalari, Kallimandarai, Kuppiyalari, Navillavalari, Perungalli ; Telugu—Arhata-ganneru, Nuruvarahalu, Vada-ganneru, Veyyivarahalu ; Tulu.—Go-sampige, Sampai ; Urdu—Achin ; Uriya—Golochi, Kat-champa, Kuto-kompa, Torato.

Botanical characters

A small tree, branches swollen and leafy at the tips. Leaves 6–12 in., oblong-lanceolate or oblanceolate, acute at both ends ; petiole 1-glandular at the top. Flowers 2 in. across, white with a yellow centre, externally tinged with pink, very fragrant. Follicles about 5 in. long.

Fig. 147. *Plumeria acuminata* Ait.

Distribution

Cultivated as an ornamental tree throughout India and has become naturalized in many places.

This plant exudes, when cut, a tenacious, milky juice which dries into a substance resembling India rubber. The milky juice is rubefacient and 3 to 4 drops of the same are used as a purgative; larger quantities are poisonous (*29*). According to Arjun (*30*), "the blunt-ended branches are introduced into the uterus to procure abortion". *Toxicity*

The bark contains a bitter glucoside named plumierid, which changes to plumieric acid after treatment with alkaline solution even in cold (*26*). The milky juice contains plumieric acid, as a calcium salt (*19*). *Constituents*

9. RAUWOLFIA Plum. *ex* Linn.

(In honour of Leonhard *Rauwolf*, a German physician and traveller of the sixteenth century.)

Shrubs or undershrubs. Leaves 3–4-nately whorled, rarely opposite; axils glandular. Flowers in 2–4-nate cymes; peduncles alternating with the terminal leaves, finally becoming lateral. Calyx 5-lobed, eglandular within. Corolla salver-shaped; tube cylindric, dilated round the stamens; throat usually hairy within; lobes overlapping to the left. Stamens included. Disc cupular or annular. Carpels 2, distinct or connate; ovules 2 in each carpel, collateral. Ripe carpels drupaceous, distinct or connate, usually 1-seeded. Seeds ovoid; albumen fleshy. *Botanical characters*

Tropical regions. *Distribution*

Rauwolfia serpentina Benth. *ex* Kurz

Fl. Brit. Ind., III, 632.

Vernacular names: BENGAL—Chandra, Chhota-chand; BOMBAY—Amelpodi, Chandra, Chhota-chand, Harkai, Karavi, Tohovanna; BURMA—Bong-maiza; HINDI—Chhota-chand, Harkai-chanda, Nai, Nakuli-kanda; KANARESE—Chandrike, Garuda-patala, Sivanabhi, Sutranabhi; MALABAR—Amelpodi; MALAYALAM—Chuvanna-avilpori, Tulunni, Vantuvala; MARATHI—Harkaya, Hadki, Harki, Mungusavel, Sapasanda; MUNDARI—Nagbail; SANSKRIT—Chundrika, Sarpagandha; TAMIL—Chivan-amelpodi, Sovannamilbori; TELUGU—Dumpara-asna, Patala-gandhi, Patal-gani, Patala-garuda; URIYA-Patal-garur, Sanochado.

An erect glabrous shrub, 1–2 rarely 3 ft. high. Leaves whorled, 3–7 in. long, lanceolate or oblanceolate, acute or acuminate, tapering gradually into the petiole, thin. Flowers white or pinkish; peduncles 2–5 in. long; pedicels and calyx red. Calyx-lobes $\frac{1}{10}$ in. long, lanceolate. Corolla about $\frac{1}{2}$ in. long; tube slender, inflated a little above the middle; lobes much shorter than the tube, obtuse. Drupes $\frac{1}{4}$ in. diam., single or didymous and more or less connate, purplish-black when ripe. *Botanical characters*

Found in the Sub-Himalayan tracts and in the plains near the foot of the hills from Sirhind eastward to Assam, especially in Dehra Dun, Siwalik range and in the Sub-Himalayan tracts of Rohilkhand, North Oudh and Gorakhpur, ascending to an altitude of 4,000 ft.; also in *Distribution*

Konkan, North Kanara, Southern Mahratta Country, Western and Eastern Ghats of the Madras Presidency (up to 3,000 ft.), many districts of Bihar, such as Patna and Bhagalpur, and in North and Central Bengal.

FIG. 148. *Rauwolfia serpentina* Benth. *ex* Kurz

Uses and properties

The root of this plant has been much valued in India and the Malay Peninsula from ancient times as an antidote against the bites of poisonous reptiles and stings of insects. It is also said to stimulate uterine contractions and to promote the expulsion of the foetus. Recently this plant has come into prominence as a remedy for insomnia, blood pressure, hypochondria, etc. The hypnotic action of the drug appears to have been known to the people of Bihar, and the practice of putting children to sleep by the drug is stated to be still prevalent in certain

parts of that province (*31*). Pammel (*4*) records this plant as a fish poison, but such use has not been observed by the present authors in India.

The popularity which the drug has gained as a specific for insanity amongst lay people shows that it probably possesses well-marked sedative properties. It has been tried by Sen and Bose in cases of insanity with violent maniacal symptoms and in cases of high blood pressure. Doses of 20 to 30 grains of the powdered root twice daily produce not only sedative effects, but also a reduction of the blood pressure. Within a week the patient's senses are said to be restored, although in certain cases the period of treatment has to be prolonged. In cases of high blood pressure without marked atheromatous changes in the vessels, these authors find the drug very satisfactory. Claims regarding its utility in fevers and during the puerperium have not been fully verified, but it would certainly be worth while to try the drug on a more extensive scale. From the data so far obtained, it promises to be a valuable addition to the list of existing sedatives in insanity and irritative conditions of the central nervous system. A large amount of pharmacological and clinical study will have to be done before the utility of the drug is fully established (*31*).

Constituents

Chemical analysis of the root has yielded five crystalline alkaloids which can be classified into two groups: (*a*) the *ajmaline* group—ajmaline, ajmalinine, and ajmalicine; and (*b*) the *serpentine* group—serpentine and serpentinine (*32*). In addition, there are some more alkaloids present in both the ajmaline as well as the serpentine group.

Pharmacological action

The pharmacological actions of the active principles of the drug have not yet been worked out satisfactorily. According to Siddiqui and Siddiqui (*32*), the white and yellow bases isolated from the roots form two distinct groups from the standpoint of physiological action. The former (ajmaline group) acts as a general depressant to the heart, respiration and nerves, and the latter (serpentine group) paralyzes the respiration and depresses the nerves, but stimulates the heart. These observations were drawn from experiments carried out on frogs and, therefore, cannot be applied *in toto* to higher animals. The lethal dose of the serpentine group of alkaloids was found to be the same as that of the ajmaline group, *viz.*, 0·5 gm per kgm of frogs; the lethal dose for rats was four times higher. Sen and Bose (*33*) studied the pharmacological action of the drug on higher animals, *e.g.*, cats. They found that the watery extract of the whole drug when injected intravenously in animals produces no appreciable effect. The resins have also been separately tried but without much effect, excepting a slight stimulation of the uterine musculature. The alkaloids isolated by

them, however, showed very definite results. The blood pressure showed a slight fall and the respiration was slightly stimulated. The heart muscle was depressed and the plain muscle like that of the small intestines, uterus, etc., was relaxed. The drug is not an irritant when taken by mouth or when introduced into the system by hypodermic or intramuscular injections. Roy (*34*) finds that reflexes and sensation of pain are not affected by ordinary doses of the drug; if, however, the dose is large it produces deep sleep, the reflexes and sensation of pain are diminished, and death may result from asphyxia due to the paralysis of the respiratory centre. The heart goes on beating for some time after the failure of respiration (*35*).

A comparative study of the pharmacological action of the alkaloids —ajmaline, serpentine and serpentinine—has been carried out by the authors. The results so far obtained are very convincing. Ajmaline which resembles serpentine in its chemical structure, also does so in its pharmacological action. Both have a depressant effect on the central nervous system and produce a fall of blood pressure, whereas serpentinine causes a rise. Experiments with an especially devised oscillograph showed that ajmaline diminishes the frequency of discharge of nerve impulse (*36*).

Feeding experiments on cats show that the total alkaloids have a more marked hypnotic effect than the individual alkaloids.

10. STROPHANTHUS DC.

(From *strophos*—a twisted rope, and *anthos*—a flower; referring to the corolla which is produced into twisted tails.)

Botanical characters

Small trees or shrubs, often climbing. Leaves opposite. Flowers usually large, in terminal cymes. Calyx 5-partite, glandular within. Corolla funnel-shaped; tube short, widening to a campanulate throat, with 10 free or connate scales; lobes overlapping to the right, produced into short or long often twisted tails. Stamens included; anthers conniving round and adhering to the stigma, cells spurred at the base. Disc 0. Carpels 2, distinct, many-ovuled; style rugose. Follicles oblong or elongate, hard, spreading. Seeds narrowed to a feathery-plumose point, base with a deciduous tuft of hairs; albumen scanty.

Distribution

Tropical regions of Asia and Africa.

Economic and toxic aspects

Two species, *S. wallichii* A. DC. and *S. wightianus* Wall., are found in Assam, Orissa and South India, but nothing is known about their medicinal or poisonous properties.

Many species of *Strophanthus* have been employed from time immemorial as arrow poisons in Africa and the Malay Archipelago. In Europe they first became known from Livingstone's travels. The seeds of *S. kombe* Oliver, which contain 2 to 3 per cent of K-stropanthin, are official in the B. P. From these Fraser isolated an amorphous glucoside, as early as 1870, and later Heffter isolated a crystalline one. An

amorphous strophanthin occurs also in *S. hispidus* DC. The third species is *S. gratus* Baill. from which in 1888 Arnaud produced the crystalline glucoside ouabain, and which was subsequently more carefully examined by Thoms and called gratus-strophanthin (*26*). The seeds of *S. kombe* also contain trigonellene, choline, etc. (*37*).

Strophanthus is an important medicine and is used as a cardiac tonic and also as a diuretic. It is intensely poisonous, being eight or nine times more so than digitalis. Its action on the heart is very similar to that of digitalis, but strophanthus has less effect on the nervous system. The so-called pure principles should not be given by mouth; strophanthin (amorphous), the only one recognized by the pharmacopoeia, undergoes decomposition in the alimentary tract especially when given in pure form. Given by mouth it is often badly tolerated and strychnine is the best antidote to the toxic effects produced by it. Signs of an overdose are headache, sense of tightness in the chest and praecordium, marked slowing of pulse or coupling of the beats, marked rise in blood pressure, cardiac arhythmia, insomnia, and nausea. These are best observed after intravenous use of the substance.

In cases of poisoning, the stomach should be emptied by an emetic or by stomach tube, dilute tannic acid solution being used to wash it out. Stimulants, *e.g.*, brandy or aromatic spirit of ammonia, may be given.

11. THEVETIA Linn.

(In honour of Andr. *Thevet*, a French Monk of the sixteenth century who travelled in Brazil and Guiana.)

Botanical characters

Glabrous shrubs or small trees with elongated branches. Leaves alternate, narrow. Flowers large, yellow, solitary or in few-flowered cymes. Calyx glandular. Corolla funnel-shaped; tube cylindric below, dilated above; lobes 5, somewhat inequilateral. Stamens adnate to the bearded corolla-throat. Disc lobed. Ovary 2-lobed, 2-celled; cells 2-ovuled. Drupe broader than long; endocarp hard, 2-celled, 2–4-seeded.

Distribution

The tropical regions of America and West Indies. One species is cultivated in India.

Thevetia peruviana (Pers.) Merr.

T. nereifolia A. Juss. *ex* Steud. of Indian Floras.

(Bastard Oleander, Exile Oleander, Yellow Oleander)

Vernacular names: Bengal—China-karab, Haldi-korubi, Kokil-phul, Kolka-phul, Kolke-phul; Bombay—Pila-kaner, Pilvala-kaner, Zard-kunel; Burma—Hypayoung-ban, Molami-yai-pan; Deccan—Pila-kanner; Gujerati—Pila-kanir, Pilo-kanera; Hindi—Kaner, Kuner, Pila-kanir, Zard-kunel; Madras—Manjal-alari; Malayalam—Pachcha-arali; Marathi—Pivala-kanhera; Mundari—Marangka-naili; Punjab—Pila-kaner, Zard-ganira, Zard-kaner; Santal—Berenjo; Tamil—Pachaiy-alari, Pachchai-alari, Tiruvachi-pu; Telugu—Pachcha-ganneru; Uriya—Konyar-phul.

Botanical characters

A large evergreen shrub or small tree, 15–20 ft. high. Leaves spirally arranged, crowded, 3–5 in. long, linear, narrowed at both ends, bright-green and shining above, margins slightly recurved. Flowers yellow, 2 in. across. Calyx persistent. Fruit broadly obovate in longitudinal section, 1¼ in. long, elliptic in horizontal cross-section, 1½ in.

broad, exocarp fleshy, black when ripe, mesocarp bony, longitudinally and transversely divided, endocarp thin, corky.

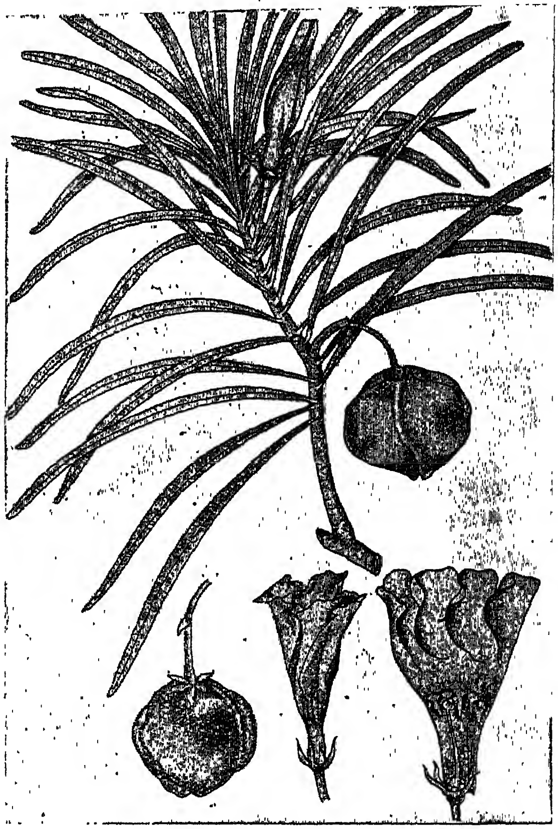

FIG. 149. *Thevetia peruviana* (Pers.) Merr.

Distribution Originally a native of America and West Indies, it is now almost naturalized in some places. There is scarcely a garden in the plains without a few cultivated shrubs, if not a hedge.

Toxicity All parts of this plant abound in a milky juice which is highly poisonous. The bark is bitter and in large doses acts as an acrid purgative and emetic and in still larger doses as a powerful poison (7).

The seeds have long been known to be highly poisonous, and have been commonly used for suicidal and homicidal purposes. They have also been used by women as an abortifacient, especially in Bengal and neighbouring provinces. Of late years, they have come into somewhat extensive use in some parts of the Bombay Presidency as a cattle

poison. The Mundas use the seeds to poison pigs and jackals. They are also said to be used in the preparation of the ipohs or Malay arrow-poisons. In Brazil the plant has been employed as a fish poison (*4, 38*).

The seeds are very bitter and, when chewed, produce a slight feeling of numbness and heat in the tongue. The more prominent symptoms of poisoning by the seeds are a burning sensation in the mouth, with tingling of tongue and dryness of the throat, vomiting and purging, with drowsiness and dilated pupils and depression of the heart's action somewhat resembling that produced by digitalis. The symptoms produced may be divided into three stages: (*a*) excitation, (*b*) depression, and (*c*) paralysis (*38*). A case is quoted by Waddell (*38*) of a child aged three years who died with tetanus-like symptoms after eating one seed and another case in which eight to ten seeds proved fatal to an adult female.

The oil extracted from the seeds is said to be emetic and purgative. According to Shortt, it produces violent vomiting and hypercatharsis (*6*). Warden, however, found the pure oil to be inert (*7*).

Constituents and action

De Vrij (*39*) extracted from the kernels a fatty oil which was 57 per cent of their weight, and isolated from the marc a water-soluble glucoside to which he gave the name thevetin. His work was continued by Blas (*40*) who assigned a formula to thevetin, and further stated that upon hydrolysis thevetin gave rise to theveresin. Both thevetin and theveresin were found to possess a digitalis-like action by Husemann and Kōnig (*41*). The nuts of the same plant have been investigated more recently and there has been considerable discrepancy of results concerning thevetin.

Lately Chen and Chen (*42*) have extracted a fatty oil, constituting more than 62 per cent of the kernel, and four crystalline substances—a phytosterolin, ahouain, kokilphin, and thevetin. The roots have also been found to contain thevetin (*43*), which is pharmacologically the most active constituent, especially on the heart (*44*, *45*, *46*, *47*). It is a glucoside and has a digitalis-like action on the amphibian and mammalian hearts. Its minimal dose necessary to produce systolic standstill in frogs lies between 0·004 and 0·005 mgm per gram body weight, and its cat unit is 0·85 mgm per kgm. Thevetin is thus one eighth to one seventh as toxic but also one eighth to one seventh as potent as ouabain (*g*-strophanthin), weight for weight. Like other digitalis bodies, it causes nausea and vomiting in sublethal doses, raises the blood pressure, and stimulates the organs having smooth muscle. Approximately 3·6 to 4 per cent of thevetin is contained in the nuts as shown by physiological assay (*45*). Its action is more prompt

but less sustained than that of digitalis, and these facts serve as a guide to its possible clinical application and limitations. The clinical trial of thevetin and other preparations of the yellow-oleander nuts in a group of 23 patients suffering from cardiac decompensation has, according to Arnold, Middleton and Chen (*46*) justified certain deductions. Thevetin is more rapidly eliminated than most substances with a digitalis-like action. This and other preparations from the nuts slowed the heart in the presence of normal conduction mechanism or of auricular fibrillation. Electrocardiograms taken during treatment were found to be closely parallel with those made during digitalis administration (*46*).

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Family LVI.—ASCLEPIADACEAE

(Asclepias and Mudar Family)

Botanical characters

Herbs or shrubs, often twining, usually with milky acrid juice; closely allied to Apocynaceae and differing chiefly in the androecium. Leaves opposite or whorled, rarely alternate (absent in *Sarcostemma*), entire, exstipulate. Flowers 5-merous, usually in axillary umbelliform cymes. Corolla-lobes valvate or overlapping to the right, rarely to the left; tube usually short, often furnished within or at its mouth with a ring of hairs, scales, or processes (*corolline corona*). Stamens at the base of the corolla; filaments sometimes free (Periploceae), but more usually connate into a fleshy column investing the pistil except the top of the stigma and usually bearing dorsal processes collectively termed the *staminal corona*; anthers crowning the column, connate or free, adnate to the stigma and the tip often produced into a membrane appressed to or inflexed over the stigma; the pollen forms 1 or 2 masses (*pollinia*) in each anther-cell, the masses of the adjoining cells of two contiguous anthers united in pairs or fours to each of the 5 minute pollen-carriers (*corpuscles*) which lie on the stigma. Ovary of 2 distinct carpels; styles 2, short, united in the large stigma, which is usually 5-angled and included between the anthers or produced beyond them into a simple or 2-fid column; ovules usually many. Fruit of 2 (–1) follicles. Seeds with a brush of hairs (coma); albumen copious.

Distribution

Mostly tropical and subtropical, rare in temperate regions.

General aspects

Some of the plants belonging to this family are weedy, some are grown in gardens for ornamental purposes, some are medicinal, but a few are of economic importance. In general, the root is acrid and sometimes emetic; the bark is purgative, and the milky juice acrid, bitter and poisonous. There is no doubt that many plants, besides those that are dealt with in this work, possess acrid and poisonous properties, but no positive information is available regarding their toxicity. Of the edible plants of this family may be mentioned *Caralluma edulis* Benth. *ex* Hook. *f.* of the Punjab and Sind, and *C. adscendens* R. Br. of South India.* Carallumas have angular fleshy stems with minute deciduous leaves.

Garden plants

Amongst the plants that are frequently cultivated in Indian gardens may be mentioned: *Asclepias curassavica* Linn. (Curassavian swallow-wort or West Indian ipecacuanha) an erect herb with handsome orange

*In Mysore villagers hold that there also exists a kind of caralluma, which, if eaten, turns the man "insane".

or scarlet flowers, and *Cryptostegia grandiflora* (Roxb.) R. Br., a large scrambling shrub with light-purple flowers; both of these plants possess toxic properties. *Pergularia minor* Andr., a large climber with greenish-yellow sweetly scented flowers, is a very common ornamental plant. *Stephanotis floribunda* Brongn. (sometimes called Madagascar jasmine), a climbing shrub with large clusters of very fragrant pure white wax-like flowers, and some other plants are also frequently met with in the gardens.

Medicinal and toxic aspects

Hemidesmus indicus R. Br. (Indian sarsaparilla) is a climber found in several places in India. The aromatic roots of this plant are much used in indigenous medicine as a tonic, diuretic, alterative, and in skin diseases, etc.; they are a commercial article of some importance in India. *Gymnema sylvestre* R. Br. ('gurmar') is a yellow-flowered extensive climber found wild in the Bombay and Madras Presidencies. The leaves of this plant, when chewed, destroy the power of the tongue to appreciate the taste of sugar and all saccharine substances for a few hours. It is also occasionally cultivated in and near the Bombay Presidency, and has the reputation of being a cure for diabetes. The antidiabetic properties of this plant have been tested but with negative results (*1*).

Indian ipecacuanha, *Tylophora indica* (Burm. *f.*) Merr. (*T. asthmatica* Wight and Arn.) is said to be an effective substitute for ipecacuanha (*Psychotria ipecacuanha* Stokes of Rubiaceae). The leaves of *T. fasciculata* Buch.-Ham. *ex* Wight are used in Southern Konkan as a poison for rats and other vermin. Mudar [*Calotropis procera* (Linn.) Dryand. or *C. gigantea* (Linn.) Dryand.] has a milky juice with caustic properties; like other irritant vegetable juices it is applied to parts locally to procure abortion, and is also taken internally for the same purpose. It is also used as an infanticide and as a cattle poison. Both these plants are also used medicinally, and the floss of the seeds is largely used for stuffing pillows. The moon plant, *Sarcostemma acidum* (Roxb.) Voigt (*S. brevistigma* Wight & Arn.), and other Indian species of the same genus are used to extirpate white ants from sugar-cane fields.

Several foreign species of *Cynanchum* are regarded as poisonous, giving rise to symptoms of gastro-enteritis or others pertaining to the muscular and nervous systems. *C. arnottianum* Wight of Kashmir and Baluchistan is stated to possess insecticidal properties. Certain species of *Asclepias*, and some other representatives of the family which are not found in India, are or are suspected to be poisonous. Condurango (*Marsdenia cundurango* Nichols.), a South American bitter and acrid climber, is recorded by Pammel as a dog poison. We have

recently learnt from the Veterinary Research Institute, Mukteswar, that the Indian *Marsdenia lucida* Edgew. is poisonous to sheep. *Gomphocarpus fruticosus* (Linn.) R. Br. *ex* Ait. (*Asclepias fruticosa* Linn.) of South Africa is a severe irritant when applied to the mucous membrane. This plant apparently contains an irritant principle, and Steyn (2) killed a rabbit in two hours by administering forty grams of the fresh flowers, leaves, and stems. The symptoms were mainly respiratory in character.

Constituents

Members of this family have been found to contain : (*a*) *alkaloids*, such as tylophorine, tylophorinine, etc., (*b*) *glucosides*, such as periplocin, asclepiadin, condurangin, chlorocodonid, dregein, gymnemin, kawarin, sarcolobid, etc., (*c*) *bitter substances*, such as those found in *Calotropis*, *Asclepias*, and *Cynanchum*, (*d*) *resins* which are toxic, (*e*) *essential oils*, such as those found in *Hemidesmus*, *Chlorocodon*, and *Decalepis*, and (*f*) *saponins*, such as those of *Cryptostegia*, *Sarcostemma*, etc.

KEY TO THE GENERA

A. Filaments free. Pollinia granular, 2 in each cell (20 in all) .. .. 3. *Cryptostegia*.

B. Filaments connate in a tube. Pollinia waxy. Anthers with a membranous inflexed tip.

- I. Pollinia in pairs in each cell (20 in all). Corolla rotate ; lobes overlapping to the right .. 6. *Secamone*.
- II. Pollinia solitary in each cell (10 in all).
  - *a*. Pollinia pendulous from the corpuscle.
    - *aa*. Stem erect. Corolla valvate.
      - 1. Coronal processes laterally compressed .. .. 2. *Calotropis*.
      - 2. Coronal processes spathulate .. 1. *Asclepias*.
    - *bb*. Stem twining or trailing (sometimes erect in *Cynanchum*). Corolla-lobes usually overlapping to the right.
      - 1. Leafy erect or twining herbs or shrubs .. .. 4. *Cynanchum*.
      - 2. Leafless trailing or twining shrubs 5. *Sarcostemma*.
  - *b*. Pollinia erect, suberect or horizontal. Coronal processes adnate to the very short column .. .. .. 7. *Tylophora*.

1. ASCLEPIAS Linn.

(**Latin name of a plant, from the Greek** ***asklepias*****, named after** ***Asclepius*** **the god of medicine.**)

Botanical characters

Perennial erect herbs. Leaves opposite, alternate or whorled. Cymes umbelliform. Sepals glandular within. Corolla rotate; lobes often reflexed, valvate. Coronal scales 5, erect, adnate to the column, spoon-shaped. Anther-tips membranous, inflexed; pollinia solitary in

each cell, pendulous, flattened, waxy. Stigma depressed, 5-angled. Follicles turgid, beaked.

Distribution In America, especially the United States, and Africa; the species described in detail in this work is cosmopolitan.

Toxic aspects Plants of this genus possess emetic and cathartic properties and several foreign species are reported as poisonous. Of the plants poisonous to livestock may be mentioned *A. galioides* H. B. & K. (whorled milkweed), *A. eriocarpa* Benth. (woolly-pod milkweed), *A. mexicana* Cav. (Mexican whorled milkweed), *A. syriaca* Linn. (milkweed), etc., which have been reported to have poisoned sheep, cattle and horses in America, sheep being the most susceptible animal. The juice of another American plant, *A. vestita* Hook. & Arn., is irritant and the plant is also said to be poisonous to livestock. *A. physocarpa* Schlecht. of South Africa is also poisonous and a severe gastro-intestinal irritant. Steyn's (*3*) experiments with the last-named plant on sheep show that in acute cases there is apathy, inappetence, cyanosis, rapid pulse, pronounced dyspnoea and fever, the animals dying a few hours after the administration of the plant. In more protracted cases there was abdominal pain, a profuse foetid diarrhoea, and loss in condition. Mettam (*4*) records fever, weakness and staggering in animals poisoned with this plant.

According to Pammel (*5*), honey bees are generally killed by becoming entangled in the pollen masses of some of the asclepias.

Asclepias curassavica Linn.

Fl. Brit. Ind., IV, 18.

(Bastard Ipecacuanha, Bloodflower, Curassavian Swallowwort, West Indian Ipecacuanha, Wild Ipecacuanha)

Vernacular names: BOMBAY—Kakatundi, Kuraki; PUNJAB—Kaktundi.

Botanical characters An erect herb about 2 ft. high. Leaves opposite, 2–3 in. long, lanceolate or oblong-lanceolate. Flowers orange or scarlet, moderate-sized; corolla reflexed. Column stipitate. Follicles about 3 in. long.

Distribution A native of the West Indies; often grown in gardens and naturalized in many parts of India.

Toxicity This plant is stated to be used to procure fish in the West Indies and in Queensland. The root and the expressed juice are emetic and cathartic. According to Dymock (*6*), the plant is said to act directly on the muscular system, and specially upon the heart and blood vessels, causing great constriction of the latter and distention of the larger arteries.

Constituents

The herb contains the glucoside asclepiadin (*7*). The roots contain vincetoxin (*8*), which closely resembles emetine in its physiological action (*6*).

FIG. 150. *Asclepias curassavica* Linn.

2. CALOTROPIS R. Br.

(From the Greek *kalos*—beautiful, and *tropis*—the keel of a boat; referring to the shape of the coronal scales.)

Botanical characters

Erect, glabrous or hoary shrubs or small trees. Leaves opposite broad, subsessile. Flowers large or medium-sized, in umbelliform or subracemose cymes. Sepals glandular within. Corolla broadly campanulate; lobes broad, naked, valvate. Coronal scales 5, fleshy, laterally compressed, radiating from the large staminal column, dorsally spurred. Anther-tips membranous, inflexed; pollen masses solitary in

each cell, pendulous, flattened, waxy. Stigma depressed, 5-angled or lobed. Follicles short, turgid, smooth.

Distribution

In tropical regions of Asia and Africa.

Medicinal and toxic aspects

The two species described in this work, *viz.*, *C. gigantea* (Linn.) Dryand. and *C. procera* (Linn.) Dryand. have such a close superficial resemblance that they are known by the same vernacular names. One or the other of these is found growing wild almost anywhere in India. Their medicinal and toxic properties are similar, and if there be any difference it is only of degree. Indeed, on this account, it is difficult to treat them separately and much of the information given generally under one is applicable the other.

Almost every part of these plants is used in indigenous medicine, and they are considered to have valuable alterative properties when taken in small doses. The flowers are considered to be digestive, stomachic, and tonic. The dried bark is used in indigenous medicine as a substitute for ipecacuanha, as an expectorant in doses of 3 to 10 grains, and as an emetic in doses of ½ to 1 drachm (*9*). The milky juice is caustic and acts as a drastic purgative, also as an emetic ; it is also used as an external application in cutaneous diseases and as a depilatory. According to Watt (*10*), (under *C. procera*), one drachm of the fresh juice will kill a large dog in 15 minutes ; its action, though slower, resembles that of hydrocyanic acid but commences with foaming at the mouth.

In India the juice of these plants is said to be used for infanticide, the fresh juice being forced down the throat of the infant. It is also used as an abortifacient, and for this purpose it is either given internally or painted over the mouth of the womb, through the vagina, when it sets up intense irritation. The juice is sometimes used for suicidal, but rarely for homicidal purposes. The leaves have also been administered with food in criminal poisoning. Sometimes these plants are used as a cattle poison.

Badhwar saw a case in the Civil Hospital at Parachinar in 1931. A child about 3 years old, accidentally during play, brought the juice of the plant (*C. procera*) in contact with his prepuce. He was brought to the hospital 2 days afterwards. The part was very much swollen and there were patches of ulceration with narcosis. The patient had difficulty in passing urine. On circumcision the g'ans penis was also found to be swollen and ulcerated.

According to some authors, an intoxicating liquor is said to be prepared from the juice of *C. gigantea ;* others believe that the juice is only an auxiliary in the fermentation of an alcohol-producing substance.

Speaking on this subject, Sir G. Birdwood (*11*) says, "The intoxicating liquor *Bar* is prepared by the tribes of Western Ghats. It is the last plant in the world from which an intoxicating spirit might be expected; and Barth also states of the tribes of the Tagamah, that they ferment their *Giya* with its milk-sap". It is remarkable that the practice of employing the juice of this plant in the preparation of intoxicating liquors should be known to the inhabitants of Western India in common with certain African tribes; but is apparently unknown to the people on the eastern side of India.

An extract of the juice of these plants produces slowing of the heart and acute gastro-enteritis when it is injected into the lymph sac of frogs; it is highly toxic to dogs and donkeys when given by mouth or subcutaneously. An alcoholic extract of the bark, given to dogs by mouth, produces persistent contraction of the intestines; given intravenously it increases the force of the heart beat and causes the isolated rabbit uterus to contract (*12*).

KEY TO THE SPECIES

a. Corolla uniformly coloured; lobes spreading .. .. 1. *C. gigantea.*
b. Corolla white with purple blotch on the erect lobes .. 2. *C. procera.*

1. Calotropis gigantea (Linn.) Dryand.

C. gigantea R. Br., Fl. Brit. Ind., IV, 17.

Vernacular names: ARABIC—Ashur, Oshor, Oshmor, Ushar; BENGAL—Akanda, Gurt-akand, Swet-akonda; BOLAN—Karagh; BOMBAY—Akanda, Akari, Akra, Mandara, Rui; BURMA—Maioh, Mayo, Mayo-beng, Mayo-bin, Mayo-mayo-pin, Mayo-pin; DECCAN—Ak, Akra; GOND—Kadrati; GUJARATI—Akado, Akdamu-jhada, Dhola-akdo, Nohano-akdo, Rato-akdo; HINDI—Ak, Akan, Akona, Akond, Ark, Lalak, Lal-madar, Madar, Mudar, Mudhar, Safed-ak; KANARESE—Arka-gida, Ekkemale, Mandara, Yekka, Yekkada-gida, Yokada; KOLAMI—Palati, Palti; KONKANI—Rhui; KUMAON—Ak, Ank; MALAYALAM—Bukam, Diensam, Erikku, Vellerikku, Yerrikku; MARATHI—Akanda, Akda, Lal-akara, Lal-madar, Lal-rui, Madar, Muda, Mudar, Rui; NEPAL—Auk; PERSIAN—Khark; SANSKRIT—Alarka, Arka, Mandara, Pratapasa, Swet-aurkum; SANTAL—Ahauna, Akauna; SIBI—Spalmai; SIND—Bij-elosha; TAMIL—Arkkam, Erukkam, Erukku, Mandarasu, Mirugusayidagam, Nubam, Sadabadam, Sadabudam, Sevverukku, Siyam, Suriyam, Suvedagusuman, Udumbaram, Vellerukku, Yerkum, Yerikan; TELUGU—Arkamu, Jilledu, Jilleru, Mandaramu, Nella-jilledu, Racha-jilledu, Uste, Tella-jilledu, Yekka; TULU—Ekkamale; URDU—Ak; URIYA—Akondo, Bikkortono, Kotuki, Orko, Uruk.

Botanical characters

A stout hoary-tomentose shrub 8–10 ft. high, occasionally subarboraceous. Leaves sessile, thick, glaucous-green, 4–8 in. long, elliptic or obovate-oblong, with a narrow cordate or often amplexicaul base. Flowers $1\frac{1}{2}$–2 in. diam., not scented. Corolla purplish or white; lobes spreading. Coronal scales hairy, shorter than the column, with 2 obtuse auricles just below the rounded apex. Follicles 3–4 in. long, recurved, turgid. Seeds with a tuft of silky hairs.

Frequently met with throughout India as a weed on fallow land and in waste ground except in the Punjab where it is sometimes found in gardens (in the Fl. Brit. Ind. the plant is mentioned as occurring in the Punjab, but this seems doubtful to us). ***Distribution***

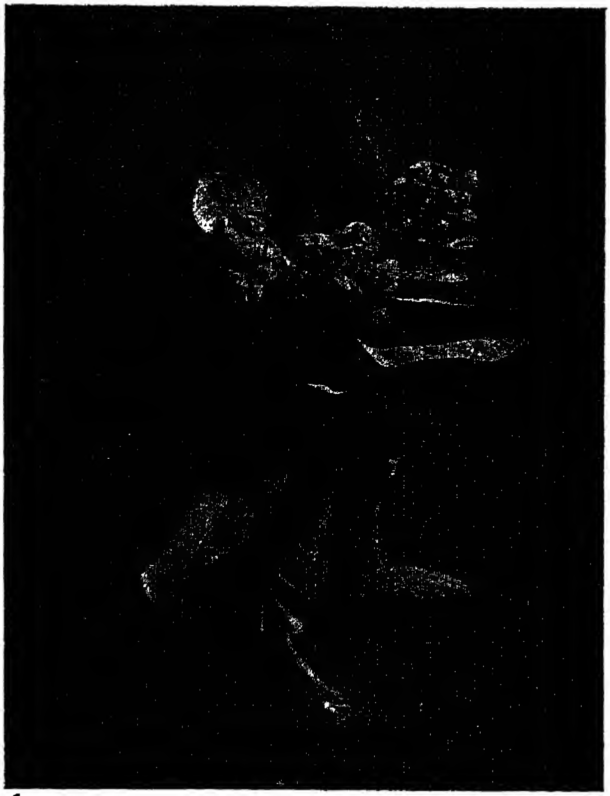

FIG. 151. *Calotropis gigantea* (Linn.) Dryand.

A kind of gutta-percha is prepared from the milky sap of this plant. The bast fibre and floss from the seeds of this and the next species, *C. procera* (Linn.) Dryand., are well known ; the latter is largely used for stuffing pillows. The mahouts use the leaves as a warm fomentation in treating abscesses of elephants. The wood has been used for preparing charcoal in the manufacture of gunpowder. Medicinal and poisonous properties of this plant have been discussed in detail under the genus. ***Uses and properties***

The fibre of this plant was found to contain a toxic bitter substance, 0·05 gm of which stopped a frog's heart in systole (*13*). The juice has been found to contain a proteolytic enzyme similar to papain (*14*). ***Constituent***

The roots contain a gutta-percha-like substance (madar alban) consisting of isovaleric esters of two alcohols, and also a bitter yellow resinous substance (*12*, *15*).

2. Calotropis procera (Linn.) Dryand.

C. procera R. Br., Fl. Brit. Ind., IV, 18.

Vernacular names: AFGHANISTAN—Spalwakka; ARABIC—Ochar, Osher; BURMA—Mayo-pin, Meho-bin; HINDI—Ag, Ak, Akada, Madar, Mudar, Safed-ak; KUMAON—Ak; MARATHI—Ak, Lal-mandar, Mandara, Rui, Tambara; MUNDARI—Kulatoa; PUNJAB—Ak, Mundar, Shakar-al-lighal, Shakar-ul-ushar; SANSKRIT—Alarka; SIND—Ak; TAMIL—Vèllerku; TELUGU—Jilledu, Mandaramu, Nalla-jilledu; URIYA—Orko.

Botanical characters — A shrub, very similar in foliage and general appearance to *C. gigantea* but not usually over 4 ft. high. Flowers about 1 in. across, scented. Corolla-lobes erect, whitish with purple blotch on the upper half. Coronal scales glabrous or pubescent, equalling or longer than the staminal column, the apex bifid and without auricles. Follicles as in *C. gigantea*.

Distribution — Found more or less throughout India in warm and dry places from the North-West Frontier Province and the Punjab to Western, Central, and Southern India. Abundant in Sub-Himalayan tracts and the adjacent plains in the north-west.

Uses and properties — The poisonous properties of this plant have been discussed under the genus, while its economic uses are the same as those of the preceding species. It is said to be used as a camel fodder (*16*), but according to Stocks, as quoted by Watt (*10*), it is one of the four plants which the camel will not eat.

Constituents — The milky juice contains a proteolytic enzyme and a toxic substance (*17*). It also contains a highly active rennin (*18*). The rootbark contains a bitter yellow resin but no alkaloid (*12*).

3. CRYPTOSTEGIA R. Br.

(From the Greek *kryptos*—hidden, and *stegein*—to cover; referring to the scales in the corolla-tube.)

Botanical characters — Large climbers. Leaves opposite. Flowers large, in terminal 3-chotomous cymes. Sepals lanceolate. Corolla funnel-shaped; tube short; throat campanulate; lobes broad, overlapping and twisted to the right. Coronal scales at the base of the throat, subulate, entire or 2-cleft. Filaments short, free; anthers acute; pollinia 2 in each cell, granular with subspathulate appendages. Stigma convex. Follicles thick, divaricate, hard, 3-winged.

Distribution — Tropical Africa, Madagascar.

Cryptostegia grandiflora (Roxb.) R. Br.

Fl. Brit. Ind., IV, 6.

Vernacular names : MALAYALAM—Pala ; MARATHI—Vilarjuti-vakundi, Vilaya-ti-vakhandi ; TAMIL—Garuda-palai, Palai, Palay.

Botanical characters

A scrambling glabrous shrub. Leaves 3–4 in. long, elliptic, obtuse, coriaceous, glossy. Flowers $1\frac{1}{2}$–2 in. diam., light purple. Coronal scales cleft into 2 filiform segments. Follicles 4–5 in. long, woody, angled or winged.

FIG. 152. *Cryptostegia grandiflora* (Roxb.) R. Br.

Distribution

A native of tropical Africa; largely cultivated in gardens throughout India. It has become naturalized in the Bombay and Madras Presidencies and in certain places in the Punjab, the United Provinces, Delhi, etc.

Toxicity

The leaves are said to be poisonous and at least one fatal case of poisoning by this plant has been reported wherein the pounded leaves mixed with water were swallowed. Half an hour afterwards persistent vomiting appeared and the patient—a male adult—died fifteen hours later, apparently from exhaustion. There was no purging, and no cerebral symptoms were observed (*19*). The leaves as well as their aqueous extracts, when administered to chickens, dogs, etc., did not show any poisonous effect (*6*).

Constituents

The whole plant abounds in a milky juice, which contains a high percentage of caoutchouc with proportionately low resin, and is consequently an excellent substitute of para rubber*. The difficulty of tapping this shrub is, however, great and other methods of extracting the rubber have hitherto proved uneconomic, even during the war-time. The leaves contain 5·1 per cent and stems 1 per cent of caoutchouc (*20*), and no alkaloid (*19*).

C. madagascariensis Boj., a foreign plant, contains a saponin and a glucoside, the latter being two and a half times as toxic as the former. The glucoside is highly poisonous and possesses properties similar to those of digitalis (*21*).

4. CYNANCHUM Linn.

(From the Greek *kuon*, *kynos*—a dog, and *ancho*—to strangle; referring to the poisonous properties of some species.)

Botanical characters

Erect or twining herbs or shrubs. Leaves opposite, rarely whorled. Cymes axillary, umbelliform racemose or subpaniculate; flowers small greenish or purplish. Corolla rotate; lobes overlapping to the right or valvate. Corona adnate to the base of the column, 5-partite or cupular or campanulate, variously toothed or lobed, with or without scales or tubercles on the inner face opposite the lobes. Anthers sessile or

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*Since the above was written, the Japanese have conquered rubber-producing areas in South-East Asia, and there is an acute shortage of rubber, a vital strategic material, in India and other Allied countries. Attention has, therefore, been focussed on sources of rubber other than *Hevea brasiliensis* (H. B. & K.) Muell. Arg. (of the Euphorbiaceae family), the well-known source of para rubber. The latex of *Cryptostegia grandiflora* closely resembles that of *Hevea brasiliensis* and is, therefore, receiving great attention in India as an alternative source of rubber. In this connection the reader is referred to some recent publications by Viswa Nath: *J. sci. industr. Res.*, 1943, **1**, 335; Griffith: *Indian For. Leaflet No. 64*, 1944; and Budhiraja: *Indian For. Leaflet No. 70*, 1944.

stipitate, tip membranous, inflexed; pollinia one in each cell, waxy, pendulous, not compressed. Follicles terete or shortly 2-winged.

Distribution

Tropical and temperate regions.

Toxic aspects

Several foreign species of this genus are poisonous, some giving rise to symptoms of gastro-enteritis. Special mention may be made of the South African plants *C. capense* Thunb. and *C. africanum* (Linn.) Hoffmgg. (*C. pilosum* R. Br.). Ingestion of these produce in livestock symptoms of muscular and nervous nature which resemble closely those produced by *Cotyledon* (family Crassulaceae), but are more acute. *C. africanum*, according to Curson (*22*), produces a form of the disease known as "krimpsiekte" which is characterized by tremors and staggering gait, the animal ultimately falling with the head retracted and limbs extended. Finally it lies in an unconscious condition. Clonic spasms of the muscles are seen early which later become tetanic. There is general tympany, the eyes are staring, the respiration is rapid and shallow, and the pulse is quickened. In severe cases there is opisthotonus, spasm of the jaw muscles, and convulsions ending in death. No information is available with regard to the Indian representatives of the genus of which there are twenty, except that *C. vincetoxicum* Pers. is suspected to have poisonous properties and that *C. arnottianum* Wight is used as an insecticide.

KEY TO THE SPECIES

a. Corolla dark-purple; segments hirsute or bearded within .. 1. *C. arnottianum.*
b. Corolla yellow, glabrous .. .. .. 2. *C. vincetoxicum.*

1. Cynanchum arnottianum Wight

Fl. Brit. Ind., IV, 22.

Vernacular names: BALUCHISTAN—Bhankalink.

Botanical characters

Erect, puberulous or a hoary plant. Leaves ovate, oblong or lanceolate, sometimes whorled. Cymes sessile. Corolla dark-purple; segments hirsute or bearded within. Coronal lobes 5, fleshy, oblong or rounded.—Closely allied to *C. glaucum* Wall. *ex* Wight of the Western Himalayas and Western Tibet with larger yellow flowers.

Distribution

Found in Kashmir at altitudes of 6,000 to 8,000 ft., and also in Baluchistan.

Toxicity

The leaves are dried in shade, powdered, and used to destroy the maggots which infest wounds in animals.

FIG. 153. *Cynanchum arnottianum* Wight

2. Cynanchum vincetoxicum Pers.

Fl. Brit. Ind., IV, 22.

Botanical characters Pubescent; stems erect, 6–18 in. Leaves shortly stalked, 2 by $1\frac{1}{2}$ in., ovate, acute. Cymes stalked. Flowers $\frac{1}{5}$ in. diam., yellow. Calyx nearly as long as the glabrous corolla. Corona deeply 5-lobed.

Distribution Found in the temperate Himalayas from Kashmir to Sikkim at altitudes of 7,000 to 11,000 ft.

Toxicity The plant, especially the root which acts as an emetic, is believed to have poisonous properties. It is stated that cattle and other domestic animals will not eat it.

Constituents The rootstock contains the glucoside vincetoxin in soluble and insoluble modifications (*23*).

The active principle of vincetoxicum seeds was found to be soluble in water, alcohol, and chloroform. A cold extract of the seeds was

the least active; an extract prepared at high temperature under partial vacuum was most active. The drug may be identical with asclepiadin; it slows the beat in both the isolated and intact frog's heart (*24*).

5. SARCOSTEMMA R. Br.

From the Greek *sarx, sarkos*—flesh, and *stemma*—a crown; referring to the fleshy corona.)

Botanical characters

Leafless trailing or twining jointed shrubs with pendulous branches. Flowers small, in umbels from the nodes or terminal. Corolla rotate; lobes broad, overlapping to the right. Corona cup-shaped, adnate to the base of the column, 10-lobed or -crenate, the lobes opposite the stamens bearing large fleshy processes which are adnate to the backs of the anthers. Column short. Anther-tip inflexed. Pollinia one in each cell, pendulous, slender, waxy. Follicles smooth.

Distribution

Tropical and subtropical regions.

Sarcostemma acidum (Roxb.) Voigt

S. brevistigma Wight & Arn., Fl. Brit. Ind., IV, 26.

(Moon Plant, Sour Creeper)

Vernacular names: BENGAL—Soma, Som-lata; BOMBAY—Lama, Soma; GUJERATI—Som-vel; HINDI—Soma, Som-lata; KANARESE—Brahmi, Hambukalli, Soma-balli, Soma-late, Vasukanti; KOLAMI—Kulu-tuar; MALAYALAM—Somam, Soma-vallari, Soma-valli, Vayastha; MARATHI—Ran-sher, Som-vel; MUNDARI—Kula-toa, Kulu-tuar; PORBANDAR—Chirodi, Sandhia-vel, Thora-vel; SANSKRIT—Soma; SIND—Thorinjal; TAMIL—Kodikkalli, Somam; TELUGU—Konda-pala, Padma-kashtam, Pulla-jemudu, Polla-tige, Pulla-tige, Soma-lata, Tiga-tshumudu, Tige-jemudu; URIYA—Borohwi, Notasiju, Somo-lota.

Botanical characters

Stems $\frac{1}{8}$–$\frac{1}{4}$ in. diam., green, glabrous; joints 4–8 in. long. Flowers whitish, $\frac{2}{5}$ in. diam., in sessile, many-flowered, terminal umbels 1–1$\frac{1}{2}$ in. diam. Column very short with the inner coronal processes almost concealing the anthers. Stigma very shortly conical or blunt. Follicles 4–5 by $\frac{1}{3}$ in., lanceolate, tapering to both ends, straight, slightly diverging when two together, thinly coriaceous.

Distribution

Usually found on arid rocks in Konkan, the Deccan, the Northern Circars, Carnatic and on Horsleykonda up to an altitude of 4,500 ft. Reported from Ranchi (Horhap forest), Singhbhum, and Puri. Occurs in Bengal, but more rarely than on the western side of India.

Uses and properties

This is one of the plants which is used as a substitute for the 'soma' plant in connection with the Vedic sacrifices; in fact it is believed by some to be the true 'soma' from which the exhilarating and intoxicating drink of the 'rishis' was prepared, but there is little evidence to support this statement. It contains a large amount of milky sap which,

according to Roxburgh (*25*), is of a mild nature and has an acid taste, and is often used by Indian travellers to allay thirst. According to Haines (*26*), the milk is used in the same way as that from calotropis and he considers that " it is probably a rank poison ". The dried stem is said to have emetic properties.

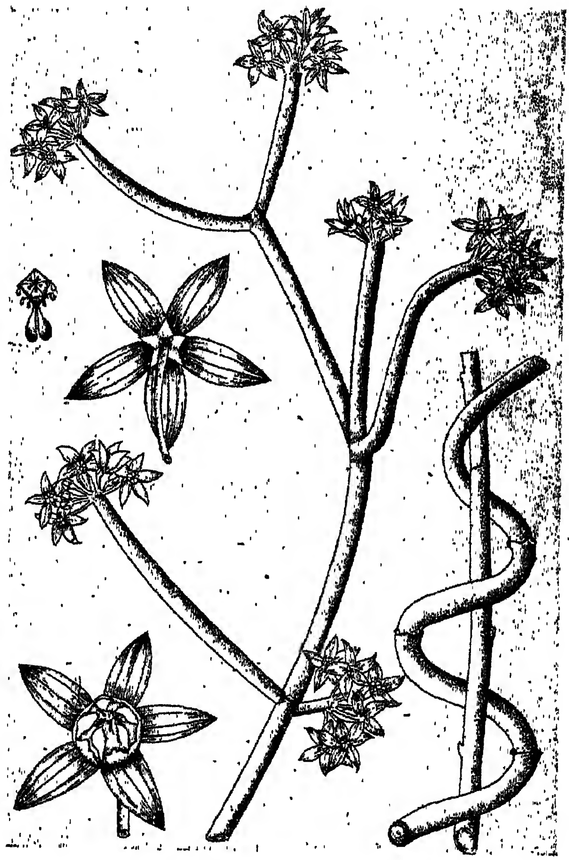

FIG. 154. *Sarcostemma acidum* (Roxb.) Voigt

According to Gibson (*27*), it is often used by farmers to extirpate white ants from sugar-cane fields. A bundle of twigs is put into the trough of the well from which the field is watered, along with a bag of salt, hard packed, so that it may dissolve gradually. The water so impregnated has been stated to destroy white ants without injuring the crop.

Other species Three other Indian species of *Sarcostemma*, which are almost indistinguishable in a dry state from this plant, are similarly used. Two of

them are inhabitants of the Western and Southern India, *viz.*, *S. brunonianum* Wight & Arn. and *S. intermedium* Decne. The third, *S. stocksii* Hook. *f.*, is found in Sind and Southern Mahratta Country, and is more robust than any of the other three. These are known by the same vernacular names as *S. acidum*.

S. australe R. Br. (caustic bush) of Australia has been proved to be poisonous to sheep, cattle and horses, as well as certain small laboratory animals. Two ounces of the plant are fatal to sheep, and 32 ounces to bovines and horses. The active principle is soluble in alcohol but insoluble in petroleum ether. It is neither a glucoside nor an alkaloid and acts chiefly on the central nervous system. The effect is almost identical with that produced by some other members of this family (*28*).

6. SECAMONE R. Br.

(Altered from *squamona*, the Arabic name of *S. aegyptiaca* Ait.)

Botanical characters

Climbing or straggling shrubs or undershrubs. Leaves opposite. Flowers small or minute, in sessile or shortly peduncled lax axillary 2–3-chotomous cymes. Corolla rotate, 5-cleft; lobes (in Indian species) overlapping to the right. Coronal scales 5, adnate to the staminal tube, laterally compressed, tips free. Filaments short, connate; anther-tips small, membranous, inflexed; pollen masses in pairs in each cell, small, globose, waxy, corpuscles minute. Stigma beaked, 2-fid, or low and conical. Follicles stout or slender, acuminate, smooth, terete or angled.

Distribution

In tropical Asia, Australia, and Mascarene Islands.

Secamone emetica R. Br.

Fl. Brit. Ind., IV, 13.

Vernacular names: Bengal—Shadaburi; Kanarese—Siranige-hambu; Tamil—Angaravalli, Kondam, Kurinja, Perunguriuja, Sagadam, Samalugam, Sarachiru.

Botanical characters

A wiry, much-branched, climbing shrub. Leaves $1\frac{1}{2}$–3 by $\frac{1}{8}$–$\frac{1}{2}$ in., lanceolate, or linear- or elliptic-lanceolate, subacute, narrowed into the short petiole. Cymes much shorter than the leaves. Corolla $\frac{1}{8}$ in. diam., glabrous. Follicles 2–$2\frac{1}{2}$ in., slender, straight, terete, narrowed from the base to the tip.

Distribution

Found in the Deccan and Carnatic, in hilly regions from Nellore to Coimbatore, extending southwards to Tinnevelly and up to an altitude of 4,000 ft. on Horsleykonda.

Toxicity

The root is acrid and is regarded as possessing powerfully emetic properties (*10*).

FIG. 155. *Secamone emetica* R. Br.

7. TYLOPHORA R. Br.

(From the Greek *tylos*—a knob or swelling, and *phoreo*—to bear; referring to the ventricose pollinia or to the coronal scales.)

Botanical characters

Twining (rarely erect) perennials. Leaves opposite. Flowers small or minute, in umbelliform or racemiform cymes. Corolla rotâte; lobes broad, slightly overlapping to the right. Coronal processes fleshy, adnate to the very short column. Anthers very small, with inflexed membranous tips; pollinia one in each cell, minute, globose or ovoid, waxy, erect, suberect or horizontal. Stigma disciform, 5-angled. Follicles acuminate.

Distribution

The tropics of the Old World and Australia.

Toxic aspects

Members of this genus exhibit emetic properties.

KEY TO THE SPECIES

a. Stems suberect with slender or twining tips. Flowers up to $\frac{1}{5}$ in. diam.	1. *T. fasciculata.*
b. Stems twining. Flowers large. Coronal processes with free cuspidate tips reaching as high as the style-apex..	2. *T. indica.*

1. Tylophora fasciculata Buch.-Ham. *ex* Wight

Fl. Brit. Ind., IV, 40.

Vernacular names : BOMBAY—Bhindodi, Bhui-dari.

Botanical characters

Stems several from the root, 1–3 ft. long, erect, flexuous or slightly twining amongst grass ; rootstock with numerous rather thick roots. Leaves petioled, 1–2 by $\frac{3}{4}$–$1\frac{1}{2}$ in., ovate or lanceolate, acute. Flowers up to $\frac{1}{5}$ in. diam., in lateral umbelliform or racemose cymes ; peduncles intrapetiolar, puberulous ; pedicels filiform ; bracts lanceolate. Sepals lanceolate, pubescent. Corolla-lobes ovate-lanceolate. Coronal processes globose. Pollinia subtransverse. Follicles $1\frac{1}{2}$–2 in. long, ovoid-lanceolate, striate ; pericarp rather thick for the genus.

Distribution

Found from the Upper Gangetic Plain eastwards to the Khasia Hills and through Central India and Konkan southwards to the Northern Circars, the Deccan and Carnatic, usually at low levels.

Toxicity

This plant is used in Southern Konkan as a poison for rats and other vermin ; it is stated to possess emetic properties.

Waddell (*19*) mentions one homicidal case of poisoning by administration of the pounded roots in food. A Mohammedan family, consisting of six adults and a servant boy aged fourteen exhibited symptoms of poisoning soon after a meal. The boy died in about two hours ; the others recovered. From the symptoms stated to have been present in this case, *viz.*, tingling in the mouth, dryness of the throat, giddiness, loss of power in the extremities, and insensibility with dilated pupils, the poison would appear to have narcotic and irritant properties. *Post-mortem* examination of the body of the boy showed bloated face, slightly protruding tongue and eyes, turgid veins of the neck ; engorged lungs ; right side of the heart full, left empty. There was slight congestion of the pia mater, and a small red patch was observed on the mucous membrane of the stomach. It was stated that in this case the accused had mixed the powdered roots of the plant with the food, on the advice of a friend who was asked for a rat poison.

Constituents

The plant is stated to contain an alkaloid (*6*).

2. Tylophora indica (Burm. *f.*) Merr.

T. asthmatica Wight & Arn., Fl. Brit. Ind., IV, 44.

Vernacular names: BENGAL—Anto-mul; BOMBAY—Anto-mul, Antha-mul, Kharaki-rasna, Pit-mari; DECCAN—Pit-kari; HINDI—Anta-mul, Jangli-pik-van; KANARESE—Adumuttada, Kirumanji-balli, Nepala, Nepalada-beru; MALAYALAM—Valli-pala; MARATHI—Pita-kari; TAMIL—Kagittam, Kagittiram, Kaludai-palai, Kodagam, Kondachani, Kuravaram, Kurinja, Nacharuppan, Nacharupaynjan, Nachchuruppan, Nanja-murichchan, Nanjaruppan, Nay-palai, Nirkkurinja, Peyppalai, Sarangam, Unmattadi; TELUGU—Kaka-pala, Kukka-pala, Mattukumittukoni, Nelatapire, Podapatramu, Tellavedavela, Tellayadala, Verri-pala, Vetti-pala; TULU—Nepala; URIYA—Mendi, Mulini.

Botanical characters

A twining perennial; roots many, long fleshy. Leaves 2–4 by 1–2¼ in., ovate or elliptic-oblong, acute or acuminate, often apiculate, base usually cordate; petiole up to 1 in. long. Flowers rather large for the genus, dull-yellow, purple within, in umbellate cymes; peduncles from

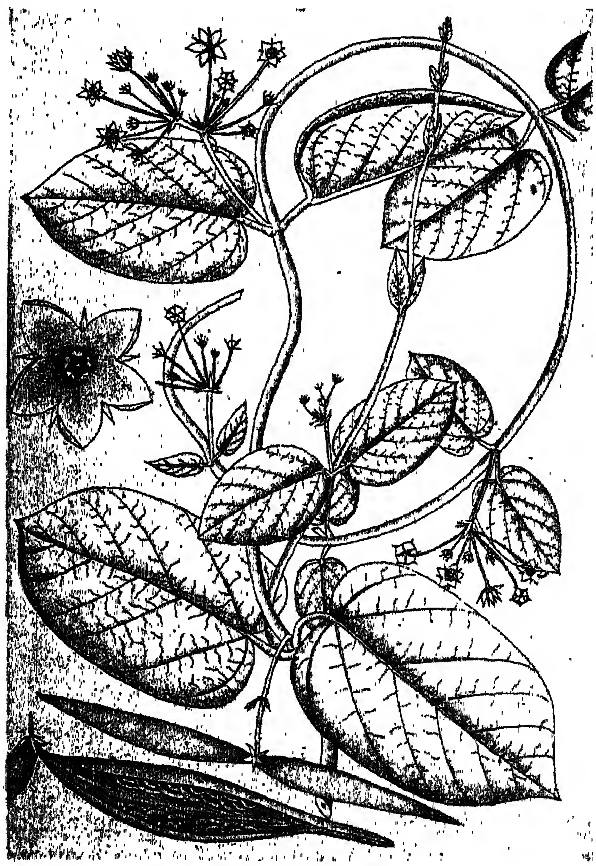

FIG. 156. *Tylophora indica* (Burm. *f.*) Merr.

between the petioles, shorter than the leaves, each bearing at its apex 2–3 nearly sessile umbels; pedicels filiform with a number of filiform hairy bracts at their base. Sepals lanceolate, hispid. Corolla-lobes oblong, acute. Coronal processes gibbous or globose with free cuspidate tips reaching as high as the style-apex. Pollinia transverse. Follicles 2–4 in. long, tapering to a fine point at the apex, scarcely tapering towards the base, finely striate.

Distribution Met with in North and East Bengal, Assam, Cachar, Orissa, Konkan, the Deccan, Kanara, and all plains districts in the Madras Presidency, in hedges and open forests up to an altitude of about 3,000 ft. in the hilly country.

Uses and properties This plant is thought to be an effective substitute for ipecacuanha, and the emetic properties of the roots and leaves are well established. The dried powdered leaves in 25 to 30 grain doses are emetic, and 3 to 5 grains thrice daily or oftener are expectorant. A concentrated infusion of the leaves has a slightly acrid taste.

Poisoning A few cases of fatal poisoning by this plant are known in India. In one case a young man, suffering from gonorrhoea, took the juice of the plant and died after about 12 hours with convulsions and unconsciousness. In another case, a man and his wife were given this plant by a quack doctor, also as a cure for gonorrhoea. Three hours later both complained of acrid feeling in the mouth and throat, followed by nausea, vomiting, purging, collapse and death next day. In both these cases the alkaloid tylophorine was extracted from the viscera. The defence of the quack was that three doses had been taken all at once, but he was sentenced (*29*).

Constituents The plant contains the alkaloids tylophorine and tylophorinine. The leaves, stem, and root contain 0·2 to 0·3 per cent of total alkaloids. The alkaloidal content does not appear to be very much affected by seasonal variations (*30*, *31*).

Action The minimal lethal dose of tylophorine for frogs is 0·4 mgm per gm of body weight. Its toxicity for mice and guinea pigs is very low The alkaloid has no irritant action locally or when injected subcutaneously or intramuscularly. The effect of the drug is especially marked on the musculature of the body, both the striped and unstriped muscles being stimulated. The action on the cardiac muscle, however, is different, the drug having a distinctly depressing effect on the heart musculature. The blood pressure is at first lowered when a dose is administered, but rises soon after and is maintained at higher level for a fairly long time (*32*).

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Family LVII.—LOGANIACEAE

(Nux-vomica Family)

Botanical characters

Trees, shrubs or herbs. Leaves opposite, rarely ternate, entire; stipules present or reduced to a raised transverse line. Flowers in simple or compound cymes, sometimes solitary. Calyx small, 4–5-toothed or -lobed. Corolla 4–5-lobed or -partite. Stamens 4–5, on the corolla-tube. Ovary free, usually 2-celled; style simple; stigma capitate, bifid or 2-partite; ovules one or more in each cell. Fruit a capsule, berry or drupaceous, 1–many-seeded. Seeds with copious albumen.

Distribution

Chiefly tropical and subtropical.

Medicinal and toxic aspects

A number of plants belonging to this family contain alkaloids which are violent tetanic poisons. The most important of these plants belong to the genus *Strychnos*, some species of which contain the highly poisonous alkaloid strychnine, which is largely used in medicine and also for destroying dogs and agricultural pests, such as rats, rabbits, foxes, etc. The seeds of nux vomica (*S. nux-vomica* Linn.) of India and Malay Archipelago and of St.-Ignatius's-bean (*S. ignatii* Berg.) of the Philippine Islands are the chief sources of this alkaloid. In most of the species of *Strychnos*, strychnine is associated with another much less toxic alkaloid brucine; the latter predominates in most cases and in some may even be the only alkaloid present in the plant. In *S. tieute* Lesch., a Java species, brucine occurs only in traces.

An aqueous extract prepared from the bark of some South American species, notably *S. toxifera* Schomb. *ex* Benth., *S. crevauxiana* Baill. and *S. castelnaei* Wedd., is the well known highly toxic curare or woorali arrow poison of the South American natives. The different kinds of curare poison are designated by the nature of containers in which they reach commerce, the constituents of the drug varying in the different specimens. Calabash (gourd) curare contains the poisonous alkaloid curarine, besides the less poisonous curine; bamboo (tube) curare from Amazon contains the alkaloids tubocurarine and curine. Pot or jar curare, which is prepared from a species of *Strychnos* and a plant belonging to the family Menispermaceae, contains the alkaloids protocurarine and protocurine. The principal effect of curare is to paralyze the motor nerve endings in striped muscles; voluntary movements are arrested and death occurs through respiratory failure. It acts promptly when introduced subcutaneously, but is much less toxic when taken by mouth on account of its slow absorption, rapid destruction in the

stomach, and quick excretion from the system. Its use in medicine is dangerous because of its varying potency and uncertain dosage. *S. tieute* Lesch. of Java also furnishes a deadly arrow poison.

Some species of *Strychnos*, like the clearing-nut tree (*S. potatorum* Linn. *f.*), however, are nonpoisonous. The seeds of this plant are used for clearing muddy water. The cut seeds are rubbed on the inside of a rough earthen vessel, which is then filled with water. On allowing the water to stand, most of the impurities settle down at the bottom of the vessel and the water becomes potable.

The root of gelsemium or the yellow jasmine [*Gelsemium sempervirens* (Linn.) Ait.] of America is used in medicine in the treatment of migraine, neuralgia, rheumatism, and in ovarian and uterine pain. It acts in the same way as nicotine and coniine, and even small doses sometimes produce toxic symptoms; it should, therefore, be used with caution. A drachm of the fluid extract is said sometimes to cause death, and 30 minims are dangerous. It contains the alkaloid gelsemine, which is less toxic than strychnine. Poisoning of horses, cattle, sheep, goats, and swine feeding on the plant has also been reported in America.

The dried rhizome and rootlets of *Spigelia marilandica* Linn. (pinkroot or Indian pink) of Southern United States have a somewhat aromatic odour and a sweetish but bitter and pungent taste. The drug is used as an anthelmintic for roundworms and contains the poisonous alkaloid spigeline, a bitter acrid resin, a volatile oil, etc. Toxic effects, which are rare, resemble those of pelletierine from *Punica granatum* Linn. (pomegranate) of the family Lythraceae.

Garden plants

Only a few of the plants of this family are cultivated in Indian gardens. In this connection, mention may be made of the exotic species *Buddleia madagascariensis* Lam., a large rambling evergreen shrub with large terminal panicles of small yellow flowers, *Nicodemia diversifolia* Tenore with greenish flowers, and the Indian *Buddleia asiatica* Lour., an evergreen shrub with white, scented flowers.

Constituents

Members of this family have been found to contain: (*a*) *alkaloids*, such as strychnine, brucine, struxine, strychnicine, bakankosine, curine, tubocurarine, curarine, protocurarine, protocurine, gelsemine, sempervirine, gelsemicine, koumine, etc., (*b*) *glucosides*, such as loganin, and (*c*) *bitter substances*.

STRYCHNOS Linn.

(From the Greek *strychnos*, a name used by Theophrastus for some plants belonging to the family Solanaceae.)

Botanical characters

Trees or scandent shrubs with short axillary often hooked tendrils. Leaves opposite, 3–5-nerved from or above the base. Flowers white or

yellowish, in terminal or axillary cymes; bracts small. Corolla 5- or 4-lobed; lobes valvate. Ovary 2-celled (or 1-celled above); stigma capitate or obscurely 2-lobed; ovules many in each cell. Berry globose or oblong, with a hard rind, many- (or 2–1-) seeded. Seeds large, embedded in pulp, globose, discoid or oblong; albumen horny.

Distribution

Tropical and subtropical regions.

Indian representatives and their constituents

This is the most important genus of the family from medicinal and toxicological points of view, and contains a number of alkaloids which are violent tetanic poisons. These have been briefly referred to under the account of the family; here it is proposed to deal in detail with the Indian species only. Some of these have been found to contain strychnine and brucine, or brucine alone. A few other alkaloids are also reported, but strychnine and brucine are the more important ones. Of all the Indian species in which these alkaloids are or may be present, nux vomica (*S. nux-vomica* Linn.) is the most important, and its seeds are the commercial source of the highly poisonous alkaloid strychnine, which has a considerable therapeutic and toxicological importance. Brucine is much less toxic and has no economic or commercial importance. Of the nonpoisonous plants, the clearing-nut tree (*S. potatorum* Linn. *f.*), which is used for clearing muddy water, is important from the economic point of view.

Uses of strychnine and poisoning

Strychnine is an extremely bitter alkaloid, perceptible even in such dilute solutions as 1 in 400,000 to 1 in 100,000, depending on the sensitiveness of the observer. It is used in medicine as a valuable bitter tonic, respiratory stimulant, and in the treatment of amblyopia of toxic origin. Mixed with starch or flour or soot, it is largely used for killing vermin which damage the cultivated fields, and for destroying stray dogs. One reason for this use is that, the action of strychnine being rapid, the animals so poisoned cannot run far away and their carcasses can thus be easily dealt with. Such a widespread use of this dangerous alkaloid, however, has not infrequently been responsible for accidental poisoning. Poisoning has also occurred through prescribing liquor strychnine along with the incompatible liquor arsenicalis, when the alkaloid is thrown down forming a poisonous dose at the bottom of the bottle. It may also occur from the deposit in the last few doses in bottles of Easton's Syrup. Harely records an unusual case in which a breast-fed infant suffered from symptoms of strychnine poisoning as a result of the medicinal administration of strychnine to the mother, who remained unaffected (*1*). In recent years strychnine powders have been largely supplied to the police for the purpose of destroying stray dogs, and several cases of human poisoning have been reported in which the poison

was obtained from this source or from its use for killing rats, etc. Accidental poisoning of animals due to its use as a vermin killer in the fields is also on record. Occasional suicidal cases are reported in India, but homicidal cases are comparatively rare.

Pharmacology of strychnine

Strychnine and the related alkaloids have a powerful stimulant action on the central nervous system, especially on the spinal cord in the vertebrates.

Strychnine acts as a powerful stimulant to the motor cells of the central nervous system and causes a pronounced increase in the reflex excitability, particularly in the spinal cord and to a less extent in the brain. On account of its action on the cerebrum the mental faculties are stimulated, the tactile and pain sensations are augmented, and the senses of hearing, smell, and taste become more acute.

In respect of the spinal cord, small doses of strychnine cause merely an exaggeration of the motor response normally resulting from a sensory stimulus applied to the surface of the body and transmitted to the spinal cord through the sensory nerves. Larger doses produce muscular twitchings or actual convulsions. When a convulsive dose is administered, all purposive reflex activity is interfered with and co-ordinated reflex actions, in which when one group of muscles contracts and inhibition of the opposing muscles occurs, can no longer take place; in fact the normal inhibition of opposing muscles is replaced by excitation, the result being a spastic condition. When an external stimulus is sufficient to cause convulsive movements in a poisoned animal the contraction is always maximal; a stronger stimulus produces no greater effect.

Besides the spinal cord, all other regions in which simple reflex can be produced, are affected by strychnine. Thus, the medullary centres are thrown into the same condition and their response to stimuli is equally exaggerated.

The stimulation of the spinal cord by strychnine is followed by depression and paralysis. The sensory parts of the spinal cord seem to be paralyzed somewhat earlier than the motor cells, but the latter also lose their irritability after a time and no further movements can be elicited either by reflex or by direct stimulation of the cord.

Strychnine seems to have no direct action on the voluntary muscles. On the peripheral nervous structures—nerve trunks and nerve endings—strychnine has no influence in mammals, though in frogs poisoned with it a curare-like action is at times discernible.

Small quantities of strychnine frequently act as a strong stimulant to the respiratory centre, especially when its excitability is depressed by the previous administration of narcotic drugs. Toxic doses may kill either through excessive excitation of the centre, the respiratory muscles being thrown into a condition of spasm and therefore of functional inefficiency or through secondary exhaustion of the same centres; death taking place from asphyxia.

In therapeutic doses, strychnine has been claimed to stimulate the vasomotor centre in the medulla. The heart is not directly affected in mammals, though it is sometimes slightly slowed by stimulation of the inhibitory centre; during and after convulsions it may be accelerated. Very large quantities slow and weaken the frog's heart. In old people with atheromatous arteries strychnine in large doses may lead to apoplexy.

Absorption of strychnine from the stomach and especially from the intestine is rapid. In man, 10 to 20 per cent of the amount ingested reappears in the urine, in which it may be detected usually within an hour and may remain for three or more days. The rest of the alkaloid is taken up by the liver where it undergoes oxidation. Tolerance is not developed; on the other hand, increased susceptibility may result after prolonged administration.

Brucine

The second aklaloid, brucine, resembles strychnine closely in its physiological action but is much weaker, 30 to 80 times being required to produce the same effect. It differs from strychnine in possessing a more powerful action on the nerve terminations in voluntary muscles, especially in some species of frogs. In addition, in 5 to 10 per cent solutions it possesses a distinct local anaesthetic action.

Vomicine

A third alkaloid, vomicine, has been isolated, which produces clonic convulsions differing from those produced by strychnine and apparently due to some action on the cerebrum.

Toxic doses of strychnine and nux vomica

In man 0·077 to 0·154 grain of strychnine may exceptionally produce convulsive effects; these become more pronounced with doses of 0·308 to 0·462 grain, and such doses may prove fatal. The ordinary fatal dose by mouth would probably be about 1·54 grains. Hewlett (2) records a case of recovery of one of his patients who had taken 15 grains of strychnine sulphate by mistake. He also mentions recovery under prompt treatment from even such exceptional doses as 75 grains, 60 grains, and 20 grains taken by mouth. The fatal dose of nux vomica ranges between 11·55 to 46·38 grains. Children are said to be comparatively less susceptible to strychnine (3).

According to Kaufmann, the toxic doses of strychnine and powdered nux-vomica seeds for animals are as follows (4) :—

	Strychnine Grains	Nux-vomica seeds Grains
Horse	3·0 to 4·5	300 to 450
Ox	3·0 to 6·0	300 to 525
Pig	0·15 to 0·75	60 to 90
Dog	0·075 to 0·30	7·5 to 15

The dose for a dog is roughly between $\frac{1}{13}$ to $\frac{1}{3}$ of a grain.

Guinea pigs and some monkeys appear to be remarkably insusceptible to strychnine administered *per os.*

Symptoms of poisoning

The preliminary symptoms of strychnine poisoning consist in restlessness and nervousness, exaggerated reflexes, muscular twitching, and sometimes a feeling of rigidity in the neck or stiffness in walking. Sudden movements, such as shrugging of a shoulder or abrupt jerking of an arm or leg, are in some degree characteristic manifestations.

After large toxic doses, the symptoms usually appear in from fifteen to twenty minutes, rarely later than an hour and often with great suddenness. Some tremors or involuntary twitches may be observed in the limbs, and then a sudden convulsion occurs in which all the muscles of the body are involved. The head is drawn back, the limbs are extended, and the trunk forms an arch with its concavity backwards (*opisthotonos*). The eyes are staring and wide open; the facial muscles are contracted, producing a hideous grin (*risus sardonicus*). The respiratory muscles are involved in the general paroxysm and the blood rapidly becomes deoxygenated. During spasms, progressive asphyxia develops ; during periods of relaxation, respiration generally returns and becomes fairly regular for a short time. Mammals, as a rule, succumb after two or three convulsions, the respiration failing to return after the spasms. In some cases, however, the convulsions become shorter, the intervals of quiescence longer, respiration becomes weak, the reflex irritability gradually lessens, and the animal dies from asphyxia.

Post-mortem appearance

The *post-mortem* appearance is that of asphyxia, the venous blood being dark and fluid and the lungs and cerebral meninges engorged. There is usually a rapid onset of cadaveric rigidity. The left ventricle of the heart is invariably empty and contracted. Very rarely, and in protracted cases, the intestines may show patchy congestion.

Treatment

The treatment consists in evacuation of the stomach with emetics or stomach tube. Some advise the administration of charcoal in order to adsorb strychnine or of potassium permanganate to destroy this

alkaloid by oxidation. To combat convulsions, inhalations of chloroform or ether are preferable to chloral hydrate by mouth. Intravenous administration of some members of the barbituric-acid series, *viz.*, sodium salts of phenobarbital, pentobarbital, amytal, etc., in doses of 7 to 10 grains, repeated in a few hours or when necessary, is followed by muscular relaxation and sleep; quite a number of cases of poisoning thus treated have recovered.

Idiosyncracy

Some persons appear to be specially sensitive to strychnine, and two cases are on record in which one twelfth and one sixth of a grain caused alarming symptoms.

KEY TO THE SPECIES

a. Climbing shrubs. Top of the ovary and style pilose .. 1. *S. colubrina.*
b. Erect trees. Ovary and style glabrous .. .. 2. *S. nux-vomica.*

1. Strychnos colubrina Linn.*

Fl. Brit. Ind., IV, 87, in part only; *S. beddomei* C. B. Clarke, Fl. Brit. Ind., IV, 88, in part.

Vernacular names: BENGAL—Kuchila-lata; BOMBAY—Goagari-lakei; HINDI—Kuchila-lata; KONKANI—Pandri; MALAYALAM—Cherukattuvalli-kaniram. Modira-kaniram, Motira-kanniram; MARATHI—Kajar-vel. Kajra-vel, Kanal, Kanel; TELUGU—Kavusu-kandira, Kousu-kandira, Naga-musadi, Naga-mushti, Tansu-paum, Tige-mushti.

Botanical characters

A large climbing shrub with bifid thickened tendrils. Leaves $3\frac{1}{5}$–$4\frac{4}{5}$ by $1\frac{3}{5}$–$2\frac{1}{5}$ in., ovate-elliptic, elliptic or elliptic-lanceolate, acute or acuminate, base rotundo-cuneate or cuneate, shining, 3-nerved, or sub-triple-nerved. Cymes axillary, about 1 in. long; peduncles and pedicels pubescent. Calyx-segments 1 mm. long. Corolla $3\frac{1}{2}$–4 mm. long, lobes 2–$2\frac{1}{2}$ mm. long, glabrous or nearly so on the outside, pilose below and at the throat. Top of the ovary and style pilose. Fruit globose, glabrous, about $\frac{3}{5}$ in. diam.; pericarp crustaceous. Seeds 1–3, $\frac{1}{2}$ in. diam., discoid.

Distribution

Found in western and southern parts of India in Bombay, Konkan, Poona, Kanara, Carnatic, Veligonda Hills of Nellore, Western Coast from South Kanara to Travancore to the lower forests of the Western Ghats.

Uses

This plant is used in indigenous medicine for the same purposes as the following species.

Constituents

The roots, seeds, bark, and wood contain the alkaloids brucine and strychnine (*5*). Strychnine is present in considerable quantities and the plant should, therefore, be employed very cautiously (*6*).

* Botanical description after Hill: *Kew. Bull.*, 1917, p. 121.

2. Strychnos nux-vomica Linn.

Fl. Brit. Ind., IV, 90.

(Nux-vomica Tree, Poison-nut Tree, Strychnine Tree)

Vernacular names: ARABIC—Khanek-ul-kella, Lzaragi, Leuzalke; BENGAL—Kochila, Kuchila, Thalkesur; BOMBAY—Jhar-kachura, Kajra, Kara, Kasarkana-mara; BURMA—Khaboung; CENTRAL PROVINCES—Kuchla; GUJERAT—Kuchla; HINDI—Baileva, Chibbinge, Chilbinge, Kajra, Kuchila, Kuchla, Nirmal; KANARESE—Hemmushti, Ittangi, Itti, Kajavara, Kanjira, Kasara, Kasarkana-mara, Kasaraka, Khaska, Kujarra, Mushti, Nanjinakoradu; KONKANI—Kazro; MALAYALAM—Kanjeram, Kannirakkuru, Kanniram, Kariram, Tettamperel-maram; MARATHI—Jhar-khachura, Kajra, Kar, Kara; NEPAL—Nirmali; ORISSA—Kachila; OUDH—Kuchla; PERSIAN—Fuluzmahi, Izaraki; PUNJAB—Kagphala, Kajra, Kuchila, Hub-ul-jarab; SANSKRIT—Kulaka, Kupilu, Vishamushti; TAMIL—Etti, Etti-kottai, Kagodi, Kalam, Kanjiga, Kanjirai, Kanjiram, Karalam, Keshama-mutti, Kiruttinabanam, Kobagundam, Kodaram, Kondagulam, Kubashuba, Madurgam, Mavagam, Mutti, Nachu, Sitti, Suvasagam, Vishamutti, Yettimaram; TELUGU—Indupu, Mushti, Musidi; TULU—Kayeru; URDU—Azaraki, Kuchala; URIYA—Kachila, Kuchla, Kera, Korra, Kosila.

Botanical characters

A deciduous tree, often with short axillary spines. Leaves 3–6 by $1\frac{3}{4}$–3 in., broadly elliptic, acute, obtuse or shortly acuminate, glabrous and shining, 5-nerved (the lateral pair often faint). Flowers many, greenish-white, in terminal short-peduncled pubescent compound cymes. Calyx $\frac{1}{10}$ in. long. Corolla a little less than $\frac{1}{2}$ in. long, 5-lobed; tube hairy inside below, the throat glabrous; lobes $\frac{1}{6}$ in. long. Ovary and style glabrous. Berry globose, 1–3 in. diam., orange-red when

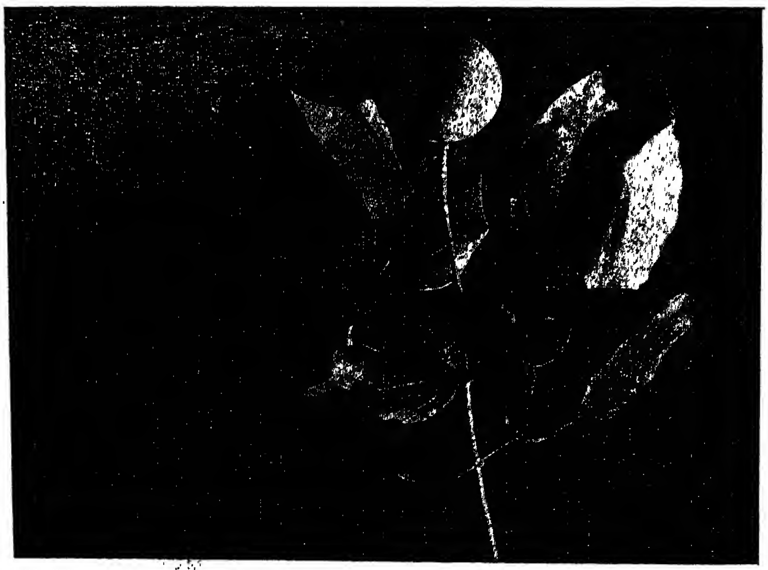

FIG. 157. *Strychnos nux-vomica* Linn.

ripe. Seeds several, discoid, about $\frac{3}{4}$ in. diam., grey, satiny, surrounded by white pulp.

Distribution

Found in the forests of Gorakhpur, Bihar and Orissa, Konkan, North Kanara, Southern Mahratta Country, Northern Circars, the Deccan, and Carnatic; also on the west coast of the Madras Presidency in deciduous forests and up to 4,000 ft. in hilly country.

Uses

The dried ripe seeds of this plant are the nux vomica of the British Pharmacopoeia and form the chief source of the valuable alkaloid strychnine, which has been dealt with in detail under *Strychnos*. In indigenous medicine, nux vomica is used as a tonic, stimulant, febrifuge, and in the treatment of cutaneous diseases especially in ulcers infested with maggots. It has been stated that it is eaten habitually as an aphrodisiac in some parts of India. The powdered seeds mixed with food are also largely given as a tonic to horses. The whitish pulp of the fruit also contains strychnine, yet it is eaten by birds, monkeys, cows, and probably other animals as well; it is also stated to be eaten by man in certain localities. It has been observed that feeding upon the leaves of nux vomica imparts a bitterish taste (so characteristic of strychnine) to the milk of cows, and the people of the locality attribute good digestibility and tonic properties to such milk, and not without reason. According to Gamble (*7*), the wood of this tree is not eaten by white ants. Watt (*6*) mentions that the seeds are employed by country distillers, who sometimes add a small quantity of them to 'arrack' so as to render it more intoxicating. He also states that the seeds are used by the hill tribes of the Nilgiris as a fish poison.

Poisoning

Poisoning by the alkaloid strychnine has been described under *Strychnos*. A case is reported by Taylor in which thirty grains of powdered seeds (equal to about one full-sized seed), taken in two doses of fifteen grains each, caused the death of a girl aged ten; and in two other cases death resulted from fifty-grain doses (*1*). It should be borne in mind, however, that owing to the insolubility of the testa the whole seed if swallowed may pass through the body without giving rise to symptoms of poisoning. Chatterjee (*8*) met with an unusual nonfatal case resulting from the introduction by a quack of a pulp made from nux-vomica seeds into a wound. A case of poisoning is also recorded in which the nux-vomica bark was substituted for that of *Holarrhena antidysenterica* Wall., a drug in common use in India. Waddell (*9*) suggests that this substitution may account partly for the great mortality among children and infants reported annually as due to tetanus in Calcutta. Instances are also on record where feeding upon nux-vomica leaves has proved fatal. Even the leaves of the parasitic

plants growing on the tree appear to acquire its poisonous properties and to contain strychnine.

Constituents

Strychnine, as stated before, is the most important alkaloid contained in this plant; besides this there are present brucine and other constituents mentioned below. These compounds exist not only in the seed, which is the most important part of the plant, but also in the root, wood, bark, leaves, pulp, etc.

The seeds may contain 1·53 to 3·42 per cent of the total alkaloids of which about half is strychnine (*10*). They also contain the glucoside loganin (*5*). Recent work shows that, besides brucine and strychnine, the seeds contain other alkaloids, such as vomicine, α-colubrine, β-colubrine, *pseudo*strychnine (*11*, *12*), etc.

The fruit pulp contains the glucoside loganin as well as brucine and strychnine (*5*).

The leaves have been found to contain the alkaloids brucine, strychnine, and strychnicine (*5*).

The bark contains chiefly brucine and only traces of strychnine, but no strychnicine. The younger barks contain 3·1 per cent and older 1·68 per cent of brucine (*5*).

The wood contains both brucine and strychnine (*5*).

The roots (old) contain 0·99 per cent of total alkaloids of which brucine forms 0·276 and strychnine 0·71 per cent (*5*).

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Family LVIII.—BORAGINACEAE

(Borage and Sebesten Family)

Botanical characters

Herbs, shrubs or trees, usually roughly hairy. Leaves alternate, rarely opposite, exstipulate. Flowers in dichotomous scorpioid cymes which are most often circinate when young, rarely solitary or subracemose, usually regular, 5- (rarely 4- or 6–8-) merous. Calyx usually persistent. Corolla often with scales in the throat; lobes usually imbricate in bud. Stamens on the tube. Ovary superior, entire or more or less completely 2–4-lobed; cells 2, each two-ovuled, or 4, each one-ovuled; style terminal or from between the ovary-lobes, simple or 1-2-forked. Fruit a drupe, or dividing into 2–4 nutlets.

Distribution

Cosmopolitan.

Medicinal and economic aspects

Very few members of this family are of any great importance. A few are used in medicine and are believed to have slightly diaphoretic, refrigerant, and demulcent properties. Some are cultivated in gardens. Many species contain a mucilage with which is often combined a bitter astringent principle.

Heliotropes, especially the cherry-pie (*Heliotropium peruvianum* Linn.), with fragrant flowers, and forget-me-nots (*Myosotis* sp.) are well-known garden plants of this family.

The mucilaginous fruit of the arboreous *Cordia dichotoma* Forst. *f.* (*C. obliqua* Willd.; *C. myxa* C. B. Clarke, *non* Linn.), called sebesten, is eaten as such or pickled; it is also used as a household remedy for cough. Leaves of *Macrotomia benthami* DC. *ex* Meissn. and those of *Onosma bracteatum* Wall. are sometimes sold under the name of 'gaozaban' in the Indian bazars, but investigations seem to have proved that the ones more commonly sold under this name are of a species of *Echium* imported from Persia. Roots of *Anchusa*, *Onosma*, *Alkanna*, and *Arnebia* yield the dye alkanet, which is used for colouring oils and waxes.

Toxic aspects

Some representatives of *Cynoglossum*, *Heliotropium*, and *Echium* are believed to be poisonous in some foreign countries. Of these may be mentioned the foreign hound's-tongue (*Cynoglossum officinale* Linn.), European heliotrope (*Heliotropium europaeum* Linn.), and blueweed [*Echium vulgare* (Tourn.) Linn.]. These and the foreign *Anchusa officinalis* Linn. and cherry-pie (*Heliotropium peruvianum* Linn.) of Indian gardens have been found to contain the toxic alkaloid cynoglossine,

which paralyzes the peripheral-nerve endings and has a curare-like action (*1, 2*). Another toxic alkaloid symphytocynoglossine, which paralyzes the central nervous system, has been found in comfrey (*Symphytum officinale* Linn.), a foreign species (*1*). Other alkaloids, such as heliotrine and lasiocarpine, have been found in *Heliotropium lasiocarpum* Fisch. & Mey.*, a doubtful Indian plant (*3*). *Cynoglossum officinale*, *Echium vulgare*, *Anchusa officinalis*, and *Symphytum officinale* also contain a toxic gluco-alkaloid, consolidine (*1*). Consolidine is stated to paralyze the central nervous system; it is hydrolyzed into glucose and consolicine, which is also found in a free state in the plant; consolicine also paralyzes the central nervous system and is said to be three times stronger than consolidine (*1*). *Heliotropium*, *Cynoglossum*, and *Anchusa* are represented in India, and it is possible that some of the species belonging to these genera are toxic. So far, however, only one Indian plant, *Lithospermum arvense* Linn., is known to contain cynoglossine.

KEY TO THE GENERA

a. Style terminal on the entire ovary .. .. 1. *Heliotropium.*
b. Style rising from between the ovary-lobes .. .. 2. *Lithospermum.*

1. HELIOTROPIUM (Tourn.) Linn.

(The classical name of *H. europaeum* Linn., from the Greek *helios*—the sun, and *tropeo*—to turn; the flowers are turned outwards and upwards.)

Botanical characters

Herbs, rarely (non-Indian species) shrubby. Flowers small, white or pale-purple, on the long scorpioid branches of 2-chotomous cymes. Calyx 5-partite or -lobed. Corolla-tube cylindrical, throat not hairy; lobes spreading in flower. Stamens included. Ovary completely or imperfectly 4-celled; style terminal, ending in a depressed conical or flat disc surmounted by the entire or bifid stigma. Fruit dry, 2–4-lobed, or of 4 more or less free nutlets.

Distribution

In tropical and temperate zones.

Uses

Some of the plants of this genus are used in indigenous medicine in the treatment of ulcers, wounds and local inflammations, scorpion or wasp stings, bites of snakes and mad dogs.

KEY TO THE SPECIES

a. Leaves up to 3 in. long at most. Fruit of 4 nutlets, not beaked .. .. 1. *H. eichwaldi.*
b. Leaves reaching 4 in. long. Fruit mitriform, 4-beaked .. 2. *H. indicum.*

* It is not certain whether this plant is found in India.

1. Heliotropium eichwaldi Steud. *ex* DC.

Fl. Brit. Ind., IV, 149.

Vernacular names: HINDI—Atwin, Bithua, Gidar-tamaku, Nil-kattai, Popat-buti; KACHHI—Popat; PUNJAB—Atnun, Bithua, Gidar-tamaku, Nil-kattei, Popat-buti.

Botanical characters

An erect annual up to 2 ft. high, branched from a woody base. Leaves 1–3 by $\frac{1}{2}$–$1\frac{1}{2}$ in., elliptic-oblong or obovate, obtuse, usually tapering to the base, entire, with glistening bulbous-based hairs. Flowers $\frac{1}{8}$ in. long, white, sessile, ebracteate, in dense, $1\frac{1}{2}$–3 in. long, 2-ranked spikes, grouped in twos or threes. Corolla hairy outside; lobes round, crenulate, often with intermediate teeth, Style scarcely any; stigma with a broad-based conical appendage bifid at the apex, stigmatic ring not conspicuous. Nutlets 4, $\frac{1}{12}$ in. long, ellipsoid, minutely verrucose and finely puberulous.

FIG. 158. *Heliotropium eichwaldi* Steud. *ex* DC.

Distribution

This plant grows commonly throughout the Punjab, Rajputana Desert, Sind, and Baluchistan, ascending in Kashmir up to an altitude of 5,200 ft. It has also been reported from Western Tibet.

Uses and properties

Besides the uses of the leaves of this plant mentioned under *Heliotropium*, they are employed externally to destroy warts, and are also given internally for their emetic properties. The plant thus has similar action to that of the European heliotrope (*H. europaeum* Linn.), which contains (*2*) the toxic alkaloid cynoglossine in its seeds and roots and which are believed as poisonous in some foreign countries. As mentioned before, cynoglossine paralyzes the peripheral nerve endings and has a curare-like action. Furthermore, this plant is very closely allied to the foreign species *H. lasiocarpum* Fisch. & Mey., which has been doubtfully referred to as Indian by Clarke in the "Flora of British India" under *H. eichwaldi*, var. *lasiocarpum*, and which contains the toxic alkaloids heliotrine and lasiocarpine in its subaerial parts (*3*).

2. **Heliotropium indicum** Linn.

Fl. Brit. Ind., IV, 152.

(Indian Heliotrope)

Vernacular names: BENGAL—Hati-sura; CENTRAL PROVINCES—Chapputattu; GUJERATI—Hasti-sundha; HINDI—Hatta-juri, Hatta-sura, Siriari; MARATHI—Bhurundi, Burundi; SANSKRIT—Bhurundi, Hati-sunada, Srihastini; TAMIL—Tolkodduki, Tolmani; URIYA—Hati-sura.

Botanical characters

A coarse annual ½–2 ft. high, with ascending hirsute branches. Leaves alternate or subopposite, 2–4 by 1–2 in., ovate or ovate-oblong, obtuse or subacute, subserrate or undulate, often with cordate base or unequal sided. Flowers $\frac{1}{5}$ in. long, lilac, sessile, ebracteate, in bristly, usually simple, 2–6 in. long, 2-ranked spikes. Stigma shorter than the style, with an annular frill at the base; apex short, obtuse. Fruit $\frac{1}{6}$ in. long, deeply 2-lobed, each lobe 4-ribbed, containing 2 angular beaked hard 1-seeded pyrenes which have each an empty cavity on the inner side.

Distribution

Common throughout India, especially in the moister regions; often in out-of-the-way corners and rubbish heaps.

Properties and constituents

Most of the uses that the plant is put to are similar to *H. eichwaldi* Steud. *ex* DC. It is stated to contain an alkaloid (*1*).

2. **LITHOSPERMUM** (Tourn.) Linn.

(From the Greek *lithos*—a stone, and *sperm*—a seed.)

Botanical characters

Herbs or undershrubs, hispid or rough. Flowers axillary, solitary or in terminal bracteate racemes. Sepals 5, linear. Corolla tubular-funnel-shaped, throat naked or with 5 small scales; lobes obtuse, spreading. Stamens included. Ovary deeply 4-lobed; style filiform

or cylindric; stigma usually 2-fid. Nutlets 4, erect, ovoid, stony: scar flat, basal; receptacle nearly flat.

Temperate regions. *Distribution*

Lithospermum arvense Linn.

Fl. Brit. Ind., IV, 174.

(Corn Gromwell, Gromwell Corn-cockle, Gromwell)

An erect annual 1–2 ft. high. Leaves lanceolate, strigose, hairs often from tuberculate bases, lower petioled, obovate-oblong. Racemes in fruit 4–10 in.; bracts leaf-like. Corolla $\frac{1}{4}$ in. long, white, rarely blue; tube not longer than the calyx. Nutlets $\frac{1}{8}$ in., ovoid-oblong, tuberculate. *Botanical characters*

FIG. 159. *Lithospermum arvense* Linn.

Found in Kashmir, Peshawar, and Western Tibet. *Distribution*

An infusion of the plant is stated to be used as a sedative in Spain. It contains cynoglossine, an alkaloid with curare-like action (*5*). It is not definitely known whether the plant contains another gluco-alkaloid consolidine, which paralyzes the central nerves system and which has been found along with cynoglossine in other plants, *e.g.*, *Cynoglossum officinale* Linn. (hound's-tongue) of Europe. The latter is believed to be poisonous in some foreign countries. *Uses and properties*

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Family LIX.—CONVOLVULACEAE

(Convolvulus and Sweet-potato Family)

Botanical characters

Herbs or shrubs, often twining, rarely trees. Leaves alternate, exstipulate, none in *Cuscuta*. Flowers often showy, solitary or in pedunculate axillary bracteate cymes. Calyx deeply 5-lobed, often persistent, sometimes accrescent. Corolla campanulate, funnel-shaped or rotate, often plicate in bud, entire or shortly lobed. Stamens 5, on the corolla-tube. Ovary superior, often surrounded by an annular disc, 1–4-celled, usually of 2 carpels; ovules usually 2 in each carpel; styles 1 or 2; stigma capitate, 2-lobed or stigmas 2. Fruit capsular, 2–4-valved, circumsciss or breaking up irregularly or indehiscent.

Distribution

Cosmopolitan, but more abundant in warmer regions.

Economic and toxic aspects

This family contains a number of plants of economic importance besides several others grown for ornamental purposes. Among the ornamental plants may be mentioned the railway creeper (*Ipomoea palmata* Forsk.) which has violet flowers with purple tube; giant potato [*I. paniculata* (Linn.) R. Br., syn. *I. digitata* Linn.] with pink-purple flowers which appear during the rainy season; morning-glory [*I. purpurea* (Linn.) Roth] with every shade of flowers from nearly white to dark purple; *I. leari* Paxt. with dark-blue flowers becoming reddish as they fade; moonflower [*Calonyction aculeatum* (Linn.) House, syn. *Ipomoea bona-nox* Linn.] with large, white and sweetly scented flowers opening only at night; red jasmine [*Quamoclit pennata* (Desr.) Boj., syn. *Ipomoea quamoclit* Linn.] with scarlet or orange flowers, etc. Indeed, there are several other creepers, particularly those belonging to the genus *Ipomoea*, that are commonly grown in gardens, houses, and at railway stations.

Ipomoea batatas (Linn.) Poir. is extensively cultivated for its well-known tuber, the sweet potato, which is widely eaten as a vegetable. There are two forms, one with red and the other with white tubers.

Many of the plants belonging to this family have an acrid taste, and when taken internally have purgative properties. These are due to the presence of resins—scammony, jalap, turpeth resin, etc.—all of which are more or less toxic and often contain glucosides or bitter principles. The turnip-like roots of jalap [*Ipomoea (Exogonium) purga* Hayne] contain a resin which is one of the most commonly used drastic purgatives of the pharmacopoeia. It is a native of the Mexican Andes, and has been experimentally cultivated in the hilly tracts of Northern and Southern India with a view to manufacturing the drug locally. The gum resin obtained from the living rhizome of *Convolvulus scammonia*

Linn. is imported into India for use as a purgative (scammony); this plant has also been experimentally cultivated in India. The roots of the Indian jalap or turpeth root [*Operculina turpethum* (Linn.) Silva Manso, syn. *Ipomoea turpethum* R. Br.] and seeds of Indian jalap or pharbitis seeds [*I. hederacea* (Linn.) Jacq.] are the well-known Indian substitutes of jalap and scammony.

The juice of *Calonyction muricatum* (Linn.) G. Don (*Ipomoea muricata* Jacq.) is stated to be used to destroy bugs. *Merremia dissecta* (Linn.) Hallier *f.* (*Ipomoea sinuata* Orteg.) of tropical America is said to contain hydrocyanic acid in its juice (*1*); this plant is becoming naturalized in some parts of India, such as the Bombay Presidency.

The leafless dodders (species of *Cuscuta*) are of interest because they grow as parasites on several plants and if left to themselves are often very destructive to their hosts. Reports from other countries show that they have caused bowel troubles to horses and other livestock who have been fed on them. *C. reflexa* Roxb. has been used as an abortifacient in India.

Constituents

The plants of this family have been found to contain: (*a*) *alkaloids*, such as convolvine, convolamine, convolvidine, convolvicine, etc., (*b*) *glucosides*, such as convolvulin, jalapin, ipomoein, turpethin, turpethein, tampicin, pharbitin, etc., and (*c*) *purgative resins*, such as those found in *Convolvulus* and *Ipomoea*.

KEY TO THE GENERA

A. Plants with well-developed leaves. Infrastaminal scales 0.
  I Pollen not spinulose.
    a. Stigma lobes oblong or linear. Capsule 4-valved .. 2. *Convolvulus*.
    b. Stigma biglobose. Capsule circumscissile above the middle. Stems winged .. .. .. 5. *Operculina*.
  II. Pollen-grain spinulose.
    a. Corolla more or less campanulate. Sepals never aristate. Stamens included .. .. 4. *Ipomoea*.
    b. Corolla more or less salver-shaped. Sepals usually aristate. Stamens exserted .. .. 1. *Calonyction*.
B. Twining leafless parasites. Corolla with infrastaminal scales 3. *Cuscuta*.

1. CALONYCTION Choisy

(From the Greek *kalo*—beautiful, and *nyktios*—nightly: referring to the beauty of the flowers and the night-blooming habit.)

Botanical characters

Large herbaceous climbers; stems usually muricate. Leaves large, cordate, entire or angled. Flowers large, white or rose-purple, solitary or in few-flowered axillary cymes; bracts caducous. Sepals usually aristate. Corolla salver-shaped; tube narrow, long, cylindric; limb plicate. Stamens 5, exserted, sometimes slightly; pollen-grains spinu-

lose. Ovary 2-celled, 4-ovuled; style filiform; stigma 2-globose. Fruit a 4-valved capsule. Seeds 4, glabrous.

Distribution Tropical Asia, Africa, and America.

Calonyction muricatum (Linn.) G. Don

Ipomoea muricata Jacq., Fl. Brit. Ind., IV, 197.

Vernacular names: BOMBAY—Gariya; KONKAN—Barikbhauri; PERSIAN—Tukhm-i-nil.

Botanical characters A large twiner; stems often muricate. Leaves 3–6 in. long, broadly ovate, acuminate, entire, glabrous, base deeply cordate and with rounded basal lobes. Peduncles 1–5-flowered; pedicels thickened upwards in fruit. Corolla 2–3 in. long, rose-purple. Capsule $\frac{1}{2}$–$\frac{3}{8}$ in. diam., globose, apiculate. Seeds $\frac{3}{8}$ in. long, smooth, polished, black.

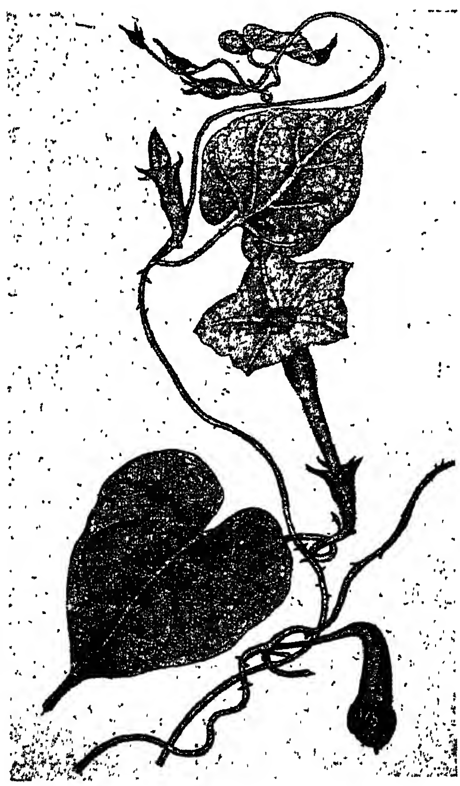

FIG. 160. *Calonyction muricatum* (Linn.) G. Don

Distribution Found in the Himalayas from Kangra to Sikkim up to an altitude of 5,000 ft., and also in the Upper Gangetic Plain, Bengal, Bihar, Orissa,

Bombay Presidency, and the Deccan hills; often cultivated for the sake of its thickened pedicels which are edible.

Uses and properties

The seeds of this plant are used chiefly as a substitute for those of *Ipomoea hederacea* (Linn.) Jacq., and have the same properties; they contain a resin (*1*). The juice of the plant is used to destroy bugs (*2*).

2. CONVOLVULUS (Tourn.) Linn.

(The classical name of the bindweed, *C. sepium* Linn., derived from *convolvo*—to roll round; referring to the twining habit.)

Botanical characters

Herbs or undershrubs, erect, prostate or twining. Leaves entire, toothed or lobed. Flowers axillary, solitary or in cymes. Sepals usually subequal. Corolla campanulate or funnel-shaped; limb plicate, subentire. Stamens included, often unequal. Ovary 2-celled, 4-ovuled; style filiform; stigmas 2, linear or oblong. Capsule 2-celled, 4-valved or bursting irregularly. Seeds normally 4, glabrous.

Distribution

Temperate regions; a few species grow in tropical regions also.

Properties

The roots of some of the plants belonging to this genus possess cathartic properties, while the leaves are mucilaginous.

Scammony

Scammony (*Convolvulus scammonia* Linn.) is a native of Syria, Asia Minor and Greece, and is most probably cultivated in some parts of India. The gum resin, obtained from incisions made in the living rhizome of this plant, is the well-known purgative which is imported into India. The drug has a cheesy odour and a slightly acrid taste. It is available as large, flat, dark-grey to blackish pieces, or irregular flattened lumps which are easily broken; thin fragments are translucent and yellowish brown. The fractured surface is glossy, and usually exhibits small cavities.

The roots contain about 9·65 per cent of the resin scammony, which consists chiefly of the glucosides and methylpentosides of jalapinolic acid and its methyl ester, besides ipuranol, tiglic acid, d-α-methylbutyric acid, scopoletin, 3 : 4-dihydroxycinnamic acid, etc. (*3*).

Convolvulus arvensis Linn.

Fl. Brit. Ind., IV, 219.

(Bindweed, Deer's-foot Bindweed, Field Bindweed, Lesser Bindweed, Small Bindweed.)

Vernacular names: Bengal—Gandhbhadali, Gondal; Gujerat—Nari, Veladi; Hindi—Beri, Harin-padi, Hiran-paddi, Prasarna, Prasarni; Kathiawar—Haran-vago, Khetranphudardi, Veldi; Marathi—Haran-pag, Hiran-pag, Chand-vel; Punjab—Harin-padi, Hiran-paddi; Sanskrit—Bhadrabala, Prosarani, Rajbala, Sarana; Sind—Hirn-pug.

A pretty, trailing or twining, glabrous or slightly pubescent herb with long cylindric slender rhizomes. Leaves 1–3 in. long, ovate or oblong-lanceolate, entire or (the lower ones) sometimes lobed, base auriculate or hastate. Peduncles 1–3 in. long, solitary, 1–3-flowered at its summit; bracts small. Sepals broadly elliptic, glabrous or nearly so. Corolla widely funnel-shaped, $\frac{3}{4}$ in. long, pink or white with a pale-yellow centre. Capsule $\frac{1}{4}$–$\frac{1}{3}$ in. diam., globose, glabrous. *Botanical characters*

FIG. 161. *Convolvulus arvensis.* Linn.

A common weed of cultivation all over India, ascending to an altitude of 10,000 ft. in the Himalayas. Well known in Britain as a troublesome agricultural weed. *Distribution*

The root possesses cathartic properties, and some European authorities regard it as poisonous because of the marked gastro-intestinal irritation it produces. The root is sometimes used in Sind as a substitute for jalap. The subaerial portions of the plant are, however, frequently eaten by *Toxicity*

livestock, and it seems that they are hardly toxic in ordinary amounts.

Constituents The rootstock contains about 4·9 per cent of a potent purgative resin (*1*).

3. CUSCUTA (Tourn.) Linn.

(Etymology doubtful; said to be derived from its Arabic name *kechout* or *kushuth*.)

Botanical characters Leafless, thread-like, yellow or reddish, twining, parasitic annuals. Flowers small, white or rose, in cymes or fascicles, 5- or sometimes 4-merous. Corolla ovoid or campanulate; tube naked or with a ring of fimbriate or lobed scales near the base or below the stamens. Stamens shortly exserted. Ovary 2-celled, sometimes incompletely, 4-ovuled; styles 1 or 2; stigmas 2. Capsule globose or ovoid, dry or fleshy, circumscissile or irregularly breaking up. Seeds 1–4, smooth.

Distribution Tropical and temperate regions.

Cuscuta reflexa Roxb.

Fl. Brit. Ind., IV, 225.

(Dodder)

Vernacular names: ARABIC—Kashus, Sharul-zabiha; ASSAM—Amarlati; BENGAL—Algusi, Haldi-algusilutta; DECCAN—Akaspavan Amarvel; GUJERATI—Akasvel, Amarabel; HINDI—Akashabela, Amarabela; JAUNSAR—Saragbali; KHARWARI—Alaj-jari; KOLAMI—Jansing; MARATHI—Akashvel, Amarvel, Nirmuli-akashavela; PERSIAN—Aftimoon, Belparash; PUNJAB—Akasbel, Amil, Nila-thari, Niradhar Zarbuti; SANSKRIT—Amaravela; SANTAL—Alag-jari; TAMIL—Kodiyagundal, Sadadari; TELUGU—Lanjasavaramu, Savarapukada, Sitama-purgonalu, Sitamma-pogunulu, Sitasavaramu; URDU—Akashbel, Imalbel; URIYA—Kolanirmuli.

Botanical characters Stems rather stout for the genus, fleshy, forming dense yellowish interlaced masses over other trees, shrubs or herbs. Flowers $\frac{1}{4}$–$\frac{1}{3}$ in. long, whitish or pinkish, fragrant, solitary or in clusters or shortly racemose; bracts small, fleshy. Corolla almost cylindrical, deciduous; lobes short, triangular, reflexed; scales at base of corolla. Ovary narrowed into a very short style with 2 lanceolate stigmas. Capsule $\frac{1}{4}$–$\frac{1}{3}$ in. diam., depressed-globose, fleshy, circumscissile near the base.

Distribution Occurs throughout the plains of India, ascending the hills up to an altitude of 8,000 ft.; often very destructive to small trees and shrubs if left to itself.

Uses and properties This plant is accredited with purgative properties, while an infusion made from it is used externally in the treatment of itch and for washing sores. The seeds are considered as carminative and alterative, and are used to purify the blood in indigenous medicine; they are also used for

local application as an anodyne. It is very likely that the properties of this parasite vary according to the host on which it grows.

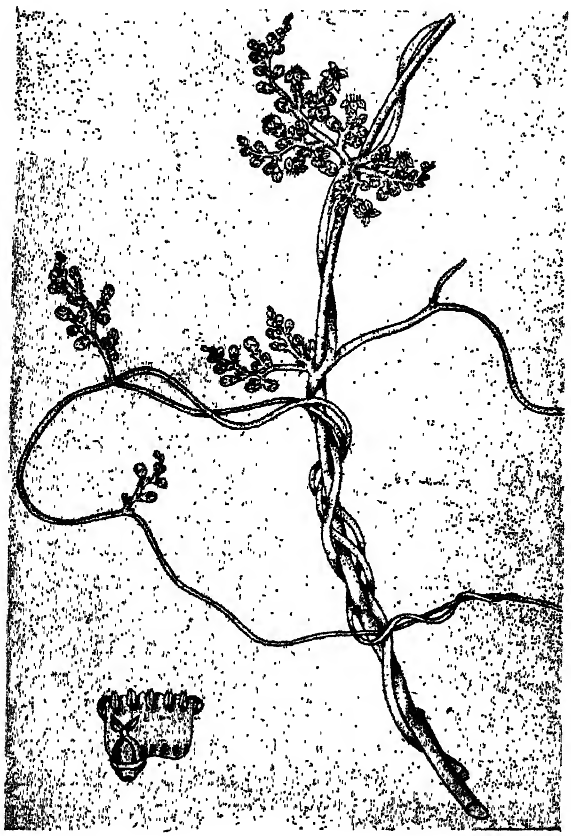

FIG. 162. *Cuscuta reflexa* Roxb.

According to Dulip Singh (*4*), the 'dais' (country midwives) in the Punjab have a great faith in a decoction of this plant* as an abortifacient. A decoction made in boiling water from 180 grains of the plant is said to produce depression with nausea and vomiting, followed by abortion.

The plant was found to contain the colouring matter cuscutin (*5*), but nothing of pharmacological importance has yet been isolated. *Constituents*

* Dulip Singh discusses the properties of this plant only under the vernacular name, 'ghagarbe l'. The authors are not aware of this vernacular name for *Cuscuta reflexa* in the Punjab where the commonest name of the plant is 'akasbel'. According to Waddell in "Lyon's Medical Jurisprudence for India," 1928, however, 'ghagarbel' and *Cuscuta reflexa* are identical.

4. IPOMOEA Linn.* (in part)

(From the Greek *ips*, *ipos*—bindweed, and *homoios*—similar; referring to the climbing habit of the species of this genus, and close resemblance to *Convolvulus*.)

Botanical characters

Twining or prostrate herbs, rarely shrubby or erect. Leaves entire or lobed or divided. Sepals 5, ovate or linear, never aristate, often accrescent. Corolla campanulate or funnel-shaped; limb plicate, slightly lobed. Stamens usually included, often unequal; pollen-grains spinulose. Ovary 2 (rarely 3 or 4) -celled; ovules 4, rarely 6; style filiform; stigma capitate, entire or 2–3-globose. Capsule 4–6-valved, rarely indehiscent. Seeds usually 4 or 6.

Distribution

Tropical and warmer regions of the globe.

Toxicity

Several plants of this genus have been used as purgatives all over the world from time immemorial. No cases of poisoning from them have been reported in India, but in large doses they would doubtless give rise to symptoms of severe gastro-intestinal irritation. Some of the species, with milder and less known action, have been left out of this work.

Jalap

Special mention may be made here of jalap [*Ipomoea* (*Exogonium*) *purga* Hayne], a climbing plant of the Mexican Andes. It occurs there between 5,000 and 8,000 ft. above sea level in localities where rain falls daily and the diurnal temperature varies from 60° to 75°F. It flourishes in shady woods in a deep rich vegetable soil. It is now being cultivated in Europe and, on account of the large demand in medicine, attempts were and are being made to cultivate it in India as well. It has been cultivated in some Himalayan valleys and in the Nilgiris. The Ootacamund variety has been found to be just as good as the imported article. The resin (jalap) from the tubers of this plant is one of the most commonly used drastic purgatives of the pharmacopoeia, producing copious, watery evacuation. In large doses it produces considerable pain, and should not be used by those suffering from gastric or intestinal inflammation. Jalap appears to act only in the presence of bile, and the addition of soap increases its purgative power. Its action on the small intestines is very rapid and it hurries their contents along; hence the liquid nature of the stools.

The tubers contain from 2·1 to 15·6 per cent (average 5·95 per cent) of the resin (*6*). Power and Rogerson found from 9 to 10 per cent of resin in the samples examined by them. The constituents of the resin were β-methyl-aesculetin, a dihydric alcohol—ipurganol, traces of an essential oil, convolvulinolic acid, some volatile acids, etc. (*7*, *8*). Some

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* *Ipomoea* of Linnaeus and in the "Flora of British India" includes, among others, the genera *Calonyction*, *Operculina*, *Quamoclit*, *Merremia*, etc. These have been treated as distinct in this work.

authors state that two glucosides, convolvulin and jalapin, are also present (*9*). Different extracts of the resin were tested by Dale on dogs, and were found to have a strong purgative action (*7*).

KEY TO THE SPECIES

a. Terrestrial Twiner .. .. 1. *I. hederacea.*
b. An aquatic plant, trailing on mud or floating .. 2. *I. reptans.*

1. Ipomoea hederacea (Linn.) Jacq.

Fl. Brit. Ind., IV, 199.

(Indian Jalap, Pharbitis Seed)

Vernacular names: Arabic—Hub-ul-nil; Bengal—Kala-danah, Mirchai Nil-kalmi; Deccan—Kali-zirki, Zirki; Gujerati—Kala-dana, Kal-kumpan, Kalo-kumpo; Hindi—Kala-danah, Mirchai; Kanarese—Ganri-bija; Kashmir—Hub-ul-nil; Marathi—Nil-pushpi, Nilyel; Persian—Tukhm-i-nil; Punjab—Bildi, Ishqpecha, Ker, Kirpava, Phapru-sag; Sanskrit—Krishnabija, Shyamabija, Shyamalabijaka; Sind—Hub-ul-nil; Tamil—Kakkattan, Kodi-kakkattan, Sirkki; Telugu—Jiriki, Kolli; United Provinces—Baunra; Urdu—Kaladanah; Uriya—Kanikhondo.

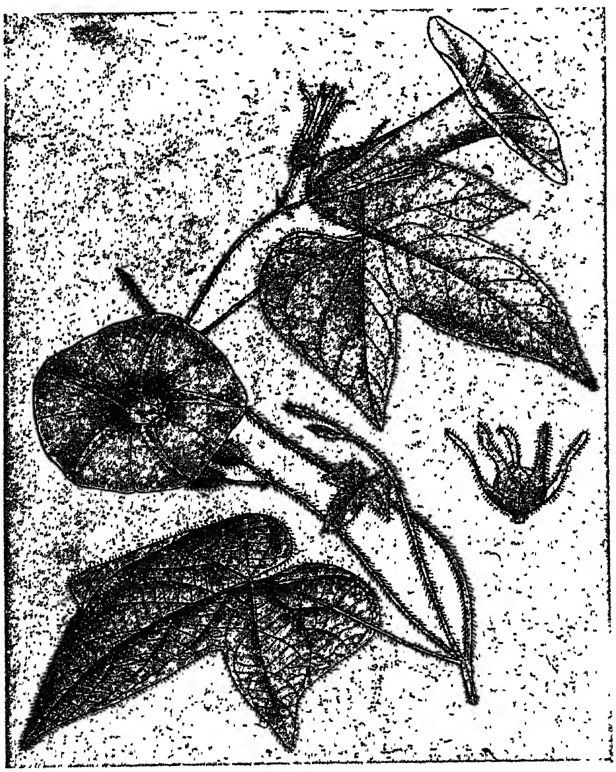

Fig. 163. *Ipomoea hederacea* (Linn.) Jacq.

Botanical characters A slender twiner; stem retrorsely hirsute. Leaves 2–5 in., ovate-cordate, 3-lobed; lobes ovate-acuminate. Peduncles 1--5-flowered, shorter than the petioles; flowers bright-blue or pink, 1½–2 in. long. Sepals linear-lanceolate, ¾–1 in. long, more or less hairy below. Ovary 3-celled. Capsule ⅓ in., subglobose, smooth. Seeds 6 or 4, glabrous.—The leaves are sometimes quite entire, ovate-or orbicular-cordate (var. *integrifolia* Choisy).

Distribution Found throughout India, both cultivated and apparently wild, up to an altitude of 6,000 ft. in the Himalayas.

Toxicity The seeds act as a drastic purgative, and are used as a cheap and useful substitute for jalap in doses of 30 to 50 grains ; they occasionally produce vomiting as well.

Constituents The seeds contain a resin from which a resin glucoside, pharbitin, has been isolated (*10, 11, 12*).

2. Ipomoea reptans (Linn.) Poir.

I. aquatica Forsk., Fl. Brit. Ind., IV, 210.

Vernacular names: BENGALI—Kalmi-sak, Nalike, Patu-shaka; BOMBAY—Nalichi-baji, Nalichi-bhaji; GUJERATI—Nalani-bhaji; HINDI—Kalmi-sag, Karmi, Patua-saga; MARATHI—Nadi-shaka; MUNDARI—Karmira; NEPAL—Kulum-sag; PUNJAB—Ganthian, Nali, Nari; SANSKRIT—Kalambi; SIND—Naro; TAMIL—Koilangu, Nir-kolmi, Sarkarei-valli; TELUGU—Tuti-kura; UNITED PROVINCES—Kalmi-sag, Nari; URDU—Nari-kakal.

Botanical characters An aquatic, glabrous herb; stems trailing on mud or floating, hollow, rooting at the nodes. Leaves 2–5 in. long, elliptic-oblong or subdeltoid, acute, base usually dilated, cordate or hastate with rounded or acute lobes, less commonly truncate. Peduncles 1--5-flowered. Flowers 1–2 in. long, white or purple with a darker purple eye. Sepals ¼–⅓ in. long, oblong-lanceolate, glabrous. Capsule ⅓ in. long, ovoid, glabrous. Seeds 4 or 2, minutely pubescent.

Distribution It is found on the edges of tanks and other moist places throughout India, especially in the Bombay Presidency, Bihar and Orissa, Bengal, and South India.

Uses In the Bengal and Madras Presidencies, it is regularly cultivated for its tender shoots and leaves which are eaten as a vegetable.

Toxicity The juice of the plant is considered to be emetic, and, according to O'Shaughnessy, when dried, is nearly equal in potency to scammony in its purgative efficacy (*2*); this statement needs corroboration.

5. OPERCULINA Silva Manso

(The capsule is operculately dehiscent.)

Botanical characters Large climbing herbs; stems, petioles, and peduncles often winged. Leaves entire or lobed. Flowers large. Sepals 5, large, glabrous,

increasing and thickening in fruit, at length splitting irregularly from the tip. Corolla funnel-shaped, rarely campanulate; tube with 5 vertical smooth bands. Anthers large, at length twisted; pollen not spinulose. Ovary 2-celled; ovules 4; style filiform; stigma 2-globose. Capsule valveless, the epicarp circumscissile above the middle, the cap carrying away the style, sometimes irregularly splitting. Seeds large, often solitary, black, smooth.

Distribution

Mostly in tropical regions.

Operculina turpethum (Linn.) Silva Manso

Ipomoea turpethum R. Br., Fl. Brit. Ind., IV, 212.

(Indian Jalap, Turpeth Root)

Vernacular names :—ARABIC—Turbund; BENGALI—Dhud-kalmi, Dudiya-kalmi, Teori, Thori; DECCAN—Tikuri; GUJERAT—Nashotar, Nahotara; HINDI—Nisoth, Nukpatar, Pitohri, Tarbud; KANARESE—Bili-tigadu; MARATHI—Dudh-kalmi, Nishottara, Phutkari, Shetar, Ter; PUNJAB—Chita-bansa; SANSKRIT—Triputa, Trivrit; SANTAL—Bana-etka; TAMIL—Shivadai; TELUGU—Tegada, Tella-tegada.

Botanical characters

Perennial with milky juice; root long, slender, fleshy, much branched; stems very long, twining and much twisted together, angled and winged. Leaves 2–4 in., ovate or oblong, subacute, mucronate, base cordate or truncate. Cymes few-flowered. Corolla white, 1½–2 in. long, sub-campanulate. Capsule ½–⅓ in. diam., globose, enclosed in the enlarged, brittle, very imbricate sepals, 4–1-seeded.

Distribution

Found throughout India up to an altitude of 3,000 ft.; also occasionally grown in gardens as an ornamental plant.

Toxicity

Cattle are not known to eat this plant (*13*). The root is very commonly used in indigenous medicine as a purgative, just as *Ipomoea* (*Exogonium*) *purga* Hayne is used in Western medicine. According to some authors, it is the root-bark and not the entire root that possesses cathartic properties. According to "Hindu Materia Medica," there are two varieties; one 'sweta' or white and the other 'krishna' or black. The former is moderately or mildly cathartic, while the black variety is said to be a potent drastic purgative which produces vomiting, fainting, and giddiness.

Constituents

The roots contain 4 to 10 per cent of a resin known as turpeth resin (*1*). The resin contains the glucosides turpethin, α-turpethein, and β-turpethein (*14*).

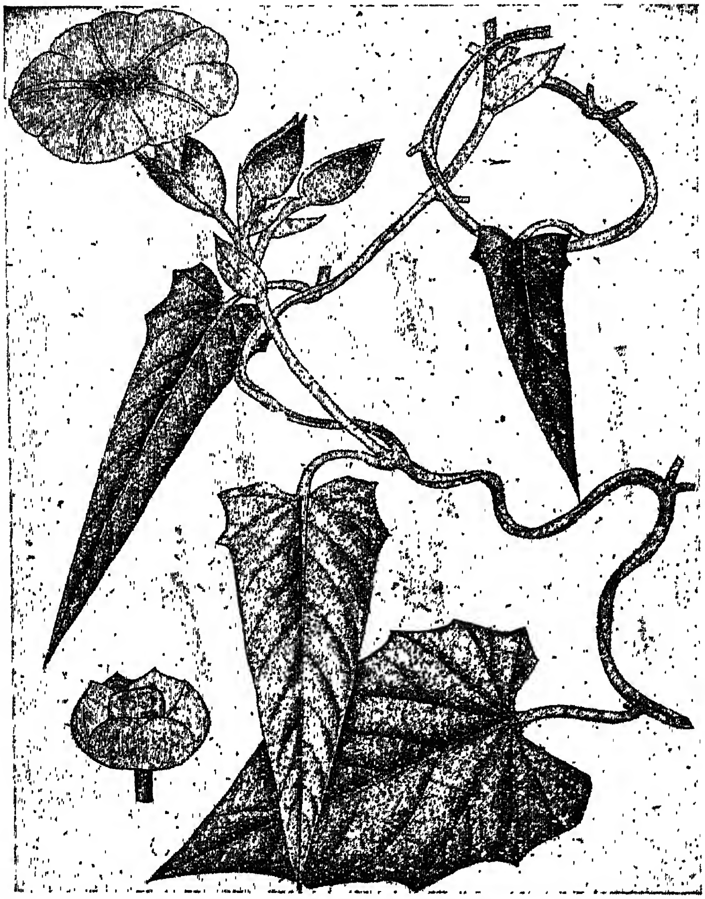

FIG. 164. *Operculina turpethum* (Linn.) Silva Manso

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